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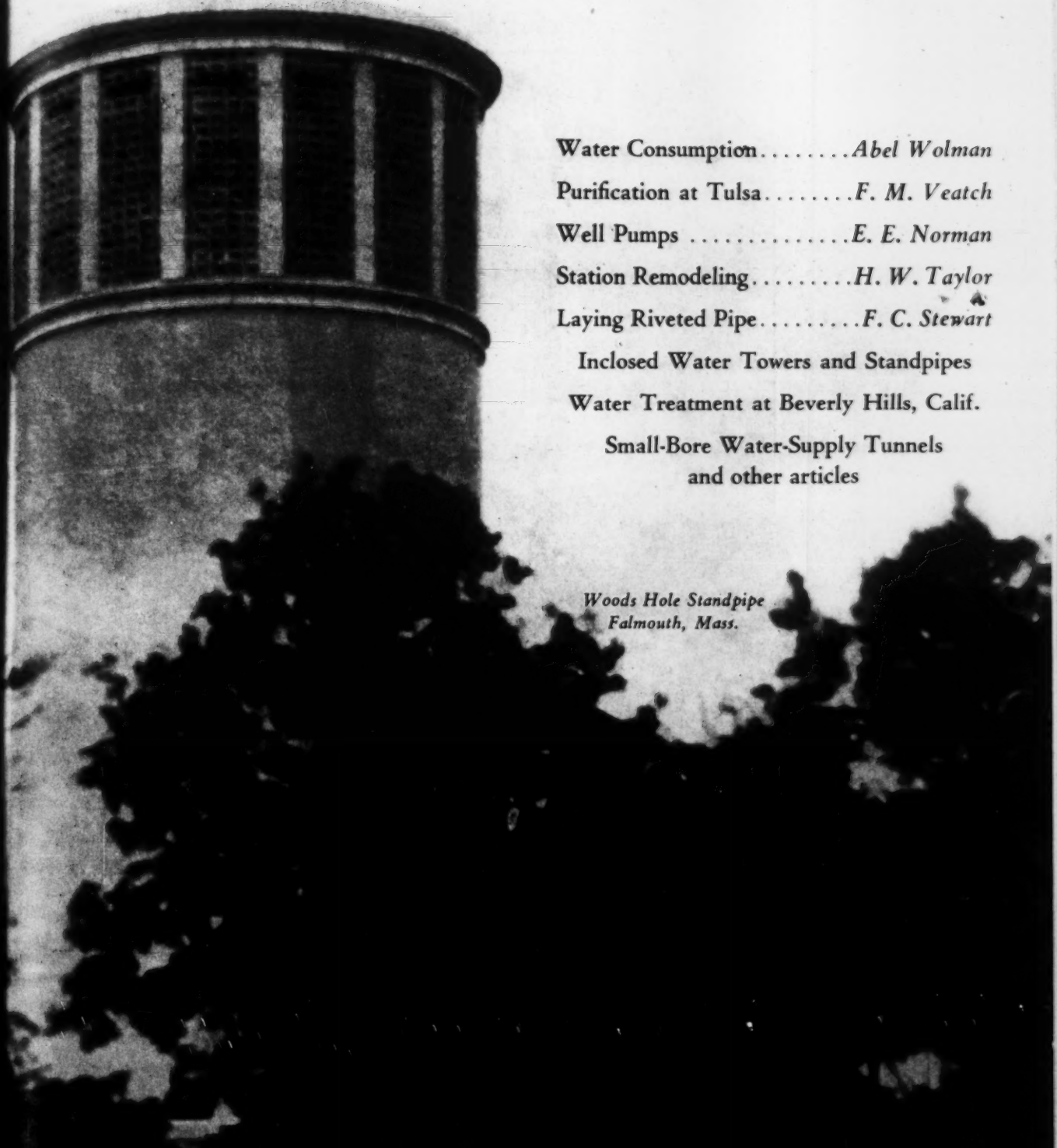

Water Consumption.....*Abel Wolman*

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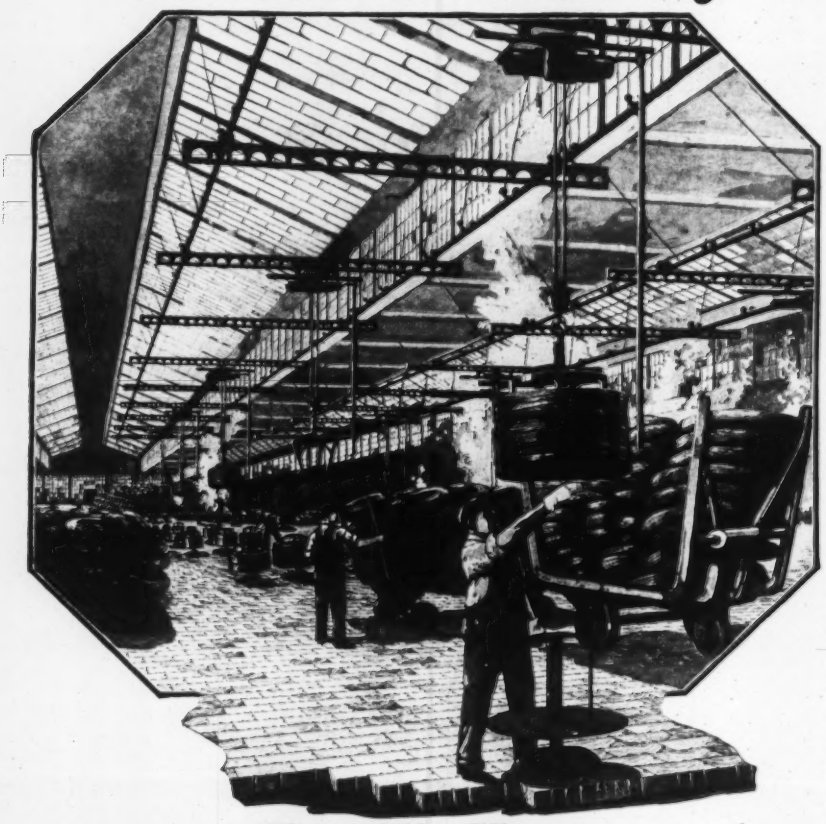

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Contents

Volume 102, Number 24, June 13, 1929

Many-Purpose Water-Treatment Plant for Beverly Hills, California 936
WELL WATER aerated, softened, filtered and chlorinated to remove hydrogen sulphide, hardness, sulphur and organisms.

Tanks and Standpipes Designed for Conspicuous Locations 939
TWO ARTICLES on interesting construction at Grover Cleveland Park, Buffalo, and at Woods Hole, Mass. By Frederick N. Wanzel and E. B. Richardson

Analysis of Variation in Water Consumption 943
FIGURES for 44 American and European cities show effect of standards of living and fluctuations in industrial conditions. By Abel Wolman

Detroit Water Board Builds for Itself and Other Departments 949
OCCUPIES nine lower floors of 20-story office building and rents remainder to other city departments. By George H. Fenkell and D. C. Grobbel

Administration Building of York Water Company 950
UP-TO-DATE and handsome structure with light and air on all sides. Meter and service house near. By Edgar P. Kable

Small-Bore Tunnel Driving in New England 951
COMPARISON of drilling, mucking and lining of water-supply tunnels at New Haven, Waterbury and Springfield.

Centrifugal and Deep-Well Pumps Draw From One Well 956
PLANT at Kalamazoo, Mich., has two types of pumps operating separately or together. Suction pipes concentric. By Earl E. Norman

Remodeling Pumping Station of Willimantic Water-Works 958
ADDING new and changing old water-power pump and improving race increase efficiency and cut out steam power. By Henry W. Taylor

Laying 20- to 60-In. Riveted Steel Pipe in the Greater Vancouver Water District 960
GENERAL FEATURES of design and successive steps in field engineering and construction in western Canada project. By F. C. Stewart

Tulsa Building a 24-M.G.D. Water-Purification Plant 964
SPAVINAW CREEK supply to be aerated, coagulated, filtered and chlorinated. Features of plant outlined. By F. M. Veatch

Feeding Chlorine Through Long Pipe Proves Satisfactory. By A. G. GRAF 938

Buggy Gives Painters Access to Water Pipe. By O. G. GOLDMAN 942

Sluicing Debris From a Clogged Water-Power Circuit 959

Records Necessary to Insure Pumping Station Efficiency. By C. D. BURDICK 963

Installing Service Pipe in Quicksand. By C. P. McGRATH 963

Anchoring a Wood-Stave Pipe in Sliding Ground. By S. C. WATKINS 966

Public Water Supplies of Holland Serve 60 Per Cent of Population 966

Editorial 933

News of the Week 967

Construction Equipment and Materials 972

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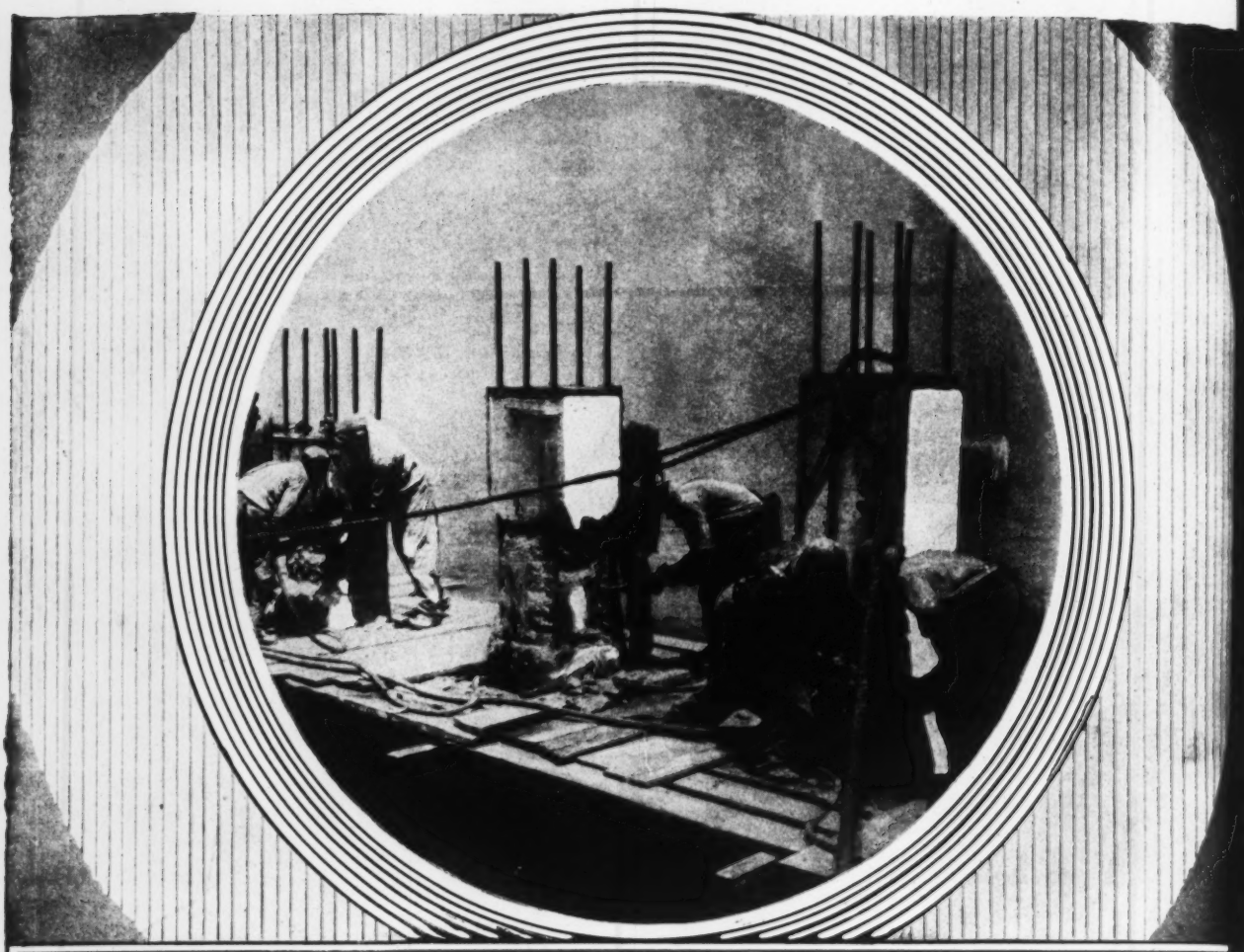

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Congratulating a Veteran

A VIGOROUS age of 60 years has been reached by the Western Society of Engineers. Last week it had a birthday dinner and laid its plans for another year without fuss as becomes a hale man when he counts threescore and feels his vigor of mind unimpaired. Sixty years is a ripe age for an engineering society in America. Chicago had not had its fire, Mrs. O'Leary's cow was not famous and the first issue of this journal had not been carried to the Chicago post office when the Western Society was born. The American Society of Civil Engineers was only a youth of seventeen and mechanical and electrical engineering did not exist as separate professions. In years no less than in service to engineering the Chicago organization is a veteran entitled to congratulations.

Welcome to the Newcomers

COMMENCEMENT is here, and once again a large contingent of young men is leaving the universities and technical colleges to enter engineering. We extend to them a cordial greeting. The career which they are taking up will, if pursued with energy and enthusiasm, bring them a fuller measure of spiritual reward and satisfaction than any other in the range of man's activities. To plan, build and operate works destined to further the well-being of mankind is a worthy occupation, one which calls forth the best effort and the highest physical and mental powers. For, after all, a man's life lies in his work, and so the engineer, in transmuting his time and thought into enduring structures, becomes more intimately interwoven with this world than do other men. Every building, every road, dam or power house that he shares in constructing is a monument to him. His name may be forgotten, but his works will live. In this thought he may cheerfully bear the hardships, the toil and the disappointments that life will bring, knowing that after all the difficulties have been overcome the fruits of his forgotten labor will remain to bless generations still unborn. Rightly therefore may the young engineer enter his life's career with ambition and with hopeful anticipation of success. Life will demand more from him and he will reach greater achievements than the present generation. We welcome him as our colleague and successor.

Future Needs

SIX years' delay intervened between the application for approval of clearance plans for the Fifty-seventh St. Hudson River bridge and the War Department's decision on the application—probably a new high record for delay, but at any rate a length of time affording ample leisure for a real study of shipping requirements and their relation to bridge clearances. So great a structure as the one proposed, a 3,600-ft. double-deck span, moreover presented a commanding occasion for clearing up this long uncertain matter, in order that an intelligent basic rule for bridge clearances might be laid down. The decision disappoints all such expectations, however, for it is a mere arbitrary dictum. This is the more astonishing since it undertakes to fix a new height standard of 200 ft. for bridges over major waterways. That such a severely restrictive limit should be set without thorough analysis of shipping developments is regrettable, for in these days of rapidly expanding communications and corresponding growth of need for crossings over main water barriers it is eminently timely that clearances be intimately correlated with transportation efficiency. Nothing contained in the War Department's decision serves to show either that the 200-ft. height is sufficient for future ship growth or that it is not excessive. Since efficient transport service to mankind demands that neither land nor water traffic should be subject to blind ruling, it is desirable that a full study of the subject be made by a competent board of shipping and commerce men, leading to a recommendation on which Congress could base its future bridge authorizations. Such a development would mark a long step in advance over the present system of bureaucratic fiat.

The President's Problem

THE decision now pending of Attorney General Mitchell on the legal status of the Jadwin plan of Mississippi flood control and the power of the Chief of Engineers to continue, without executive interference, with the award of contracts for the west bank floodway will place on President Hoover a definite engineering task of importance. Should the opinion grant the right of the Chief Executive to call for review of the Jadwin plan, the task of naming a review body and specifying its powers and procedure calls for the exercise of high judgment. If, as is extremely likely to be the case, the Attorney General decides that all the requirements of the law of June 15, 1928, have been complied with and that the approval of President Coolidge was unconditional, the duty of the President is that of direct initiative in demanding a reconsideration of the flood-control act by Congress. It is not conceivable in the face of the existing opposition that mere announcement of legality will content the President. Positive action by him will be expected. This calls for courage. The engineers of the army may be expected to muster all their resources in opposition. These resources are great. With them there will be the forces of every interest in the valley except the property interests in and adjacent to the floodway areas. With the President there will be the floodway landowners and the expressed opinion of the civil engineering profession that a great engineering undertaking is going ahead under arbitrary and ill-considered plans and that there should be a review of the whole engineering and economic problem of Mississippi Valley flood control. Will the call of engineering judgment prevail or will

there be again bureau dictatorship of the kind that last year swept out of the path of the Chief of Engineers every objection to his personal ukase? President Hoover has in his decision a vital question of engineering and government when Attorney General Mitchell announces his findings.

Protect the Highway From Politics

AGAIN a state highway engineer has been compelled to resign—a new instance of the ever-present danger of political intrusion into highway work. L. R. Ames, brought to Louisiana last February to direct as state highway engineer its great roadbuilding program, has resigned because political interference has made such action "mandatory as a duty to the state and for personal self-respect and reputation." His action, be it noted, was provoked by direct trespass of politics on the field of engineering responsibility.

This fact is of vital concern to the future highway progress of Louisiana. Going beyond his legitimate rights of general governorship into the dictation of road plans and types, of department organization, of employment, purchases and contracts, the state executive is inviting a situation that will be paid for by inefficiency and waste. This is poor regard for the ambitious purpose expressed last fall in the appropriation by the people of many millions to pull their highways out of the mud.

It is of even larger concern that the forces at work in the administration of highways in Louisiana are widely active. Throughout the nation, now in one state and then in another, politics is intruding into roadbuilding. A shift in state politics brings a highway engineering department upset. Engineers are forced into other employment, in rebellion against infringement of their technical freedom. Governors are usurping the prerogatives of the constituted public-roads officials. Trade interests are creeping into highway councils by the infiltration of chosen candidates and appointees for office. Few states in the last few years have escaped attack from those who seek by one form or another of political tactics to gain influence in the direct management of public roads.

When a decade ago the American public turned to highway improvement in a large way, the movement took on something of the spirit of a crusade. Congress, in enacting a federal-aid law requiring separate divisions of state governments to have direction of state roads administration and calling for definite system designations and guarantees of maintenance, had purposefully in view a reform of the old system of direct political control changed at every election. The response to this action carried the reform spirit into state and county road administration and set up higher public roads standards.

The states invited business men and administrators into their highway commissions, and these men engaged the technicians and built up the engineering organizations demanded for the competent design and construction of the higher types of road structure required by mechanical traction. The public responded with money in such amounts as almost staggered comprehension. It responded with confidence in its highway administrators. There has never been in the history of public works such full faith in their direction and such generous support of this faith with money.

With the enormous growth in expenditure, there grew desire and temptation to control it for political purposes. The leaders drafted to put the great state road programs on foot saw their original tasks accomplished and retired to their private businesses. The public, with confidence established in its highway administrators, ceased to keep guard and the infiltration of politics into highway administration began.

Engineering order in highway management may still persist, but decadence of morale is affecting an alarming number of highway engineering departments. This is not the ultimate penalty, however; as the power of politics becomes firmer it will be succeeded by inefficiency and venality. The remaining course needs no charting. At its end lie public distrust and curtailment of funds.

To avoid this failure of a great public improvement well begun, positive action is demanded by the agencies concerned in highway development. The public requires leadership. In large measure the roadbuilding industry is organized to give this leadership if it will turn from technicalities and trade to the fundamental task of preserving its source of business. Resignations like that of L. R. Ames in Louisiana must become an impossibility.

Current Water-Works Development

INCREASING demands press in upon the engineers and administrators of public water supplies as they do upon other engineers, but with more urgency because one of man's primal necessities of life is involved—one closely related to varying standards of living, as is brought out clearly in Abel Wolman's analysis. The rate of progress in the field of water-works is therefore accelerating. A group of articles has been assembled in this issue to give expression to the multiplicity of problems involved. In the annual gathering of his profession soon to be held at Toronto the engineer will be of largest influence if he brings to it progressive thought based on keen appreciation of the growing demands placed upon his art.

SCATTERED up and down on the face of the earth, in city and country alike, are the many creations of the engineer. All too rarely does this servant of the public realize that with him lies the choice between making these works blots and scars on the landscape or pleasing additions to its endless variety—welcome breaks in its monotony. This is particularly true in the field of water-works design and construction. Here to the natural setting the engineer adds dams, reservoirs, pumping stations, filtration plants, aqueducts often visible, and—last but by no means least in possibility of defacement or enhancement of the landscape—tanks and standpipes.

These latter structures will be either abhorred or admired by thousands. As the years have gone by, attempts at pleasing designs have multiplied. The two examples of such attempts illustrated in this issue are gratifying. The growing recognition of the amenities in the design of these and other water-works structures deserves praise and emulation.

No doubt a large extra cost of the Woods Hole standpipe was entailed by the inclosure. Unfortunately, separate cost figures for the Grover Cleveland Park tank at Buffalo are not available. Presumably the additional cost of a pleasing structure here was not so great as at Woods Hole, for the tank at Buffalo had to be supported at an elevation of something like 100 ft., whereas the Woods Hole standpipe is its own support. Even more interesting because more novel and of larger scope is

the architectural inclosure of multiple water tanks at Cincinnati, described in our issue of March 14, 1929, p. 414. Groups of tanks have been built elsewhere, in a few cases, but so far as we know they have not been inclosed and in a degree have been not only multiple tanks but also multiple blots on the landscape.

NOT alone obstacles set by nature but also man-made obstacles confront the supplier of water, and may force him to turn from a relatively simple solution of his immediate problem to one that is complex and presents many difficulties. This was the case when engineers charged with providing an additional water supply for Beverly Hills, Calif., found that instead of adopting the very simple expedient of tapping the Los Angeles aqueduct they were forced to provide water from sources within the municipal boundary lines, thus making it necessary to design and build what is described elsewhere in this issue as a "many-purpose" water-treatment plant. The charter of Los Angeles prohibits the city from supplying water to other communities, even though these be completely surrounded by the city, as is Beverly Hills. The only available supply was underground water containing such mineral compounds as make it impossible for use, in these days of fastidiousness concerning water, without elaborate treatment. Moreover, the treatment problem was made more difficult by the action of the mineral and resulting biological contents of the water upon the filtering medium. The article illustrates anew the task of the engineer in coping with both natural and man-made obstacles, and also the distance the engineer now goes in providing what the late Prof. William T. Sedgwick called "water refining."

THE new constitution of the American Water Works Association, to be submitted to the Toronto convention during the week beginning June 24 and afterward to go to letter ballot, complies in the main with the present-day conception of a constitution. It is brief and is directed primarily to an unequivocal and easily understandable statement of objects and membership, to relatively unchanging governmental principles and to choice of a thoroughly representative governing body.

The bylaws, being made subject to amendment by the governing body, can quickly be adapted to changing needs of the association. Representation on the governing body is to be chiefly by local sections, a noteworthy change from the existing plan of organization. Equally noteworthy is the innovation of giving representation on the governing body to the Water-Works Manufacturers Association and to the Committee on Water-Works Practice and the Publication Committee—commendable changes. Efficient administration is also furthered by providing for special meetings in various parts of the country, and by placing the choice of meeting place—now a picturesquely clamorous spectacle at the convention—in the control of the governing body.

By establishing a committee on water-works practice, the constitution crystallizes a change already begun, in substituting for a somewhat uncoordinated standardization council, never recognized in the constitution, a committee so recognized. The change is probably well advised, but it should never be forgotten that the standardization council and the energy that was put into it and its various subcommittees did a vast amount of valuable creative work.

On the whole, the new constitution of the American Water Works Association does credit to its framers. The association will be strengthened by its adoption. We commend it for study to other professional societies whose constitutions have not yet been adjusted to present-day needs.

USEFUL data on methods of laying riveted pipe are given in the article in this issue analyzing current practice of the Greater Vancouver Water District. Riveted pipe construction has been a part of general civil engineering activity for so many years that many regard it as standardized beyond discussion or improvement. A similar state of mind also is hampering other old methods of construction which might yield economies and improvements in efficiency that are now being missed. The analysis of riveted steel pipe construction at Vancouver showed among other things that fair holes requiring a minimum of reaming are an important factor in making joints watertight, and that accurate methods easily followed would produce these closely matched holes. The analysis revealed other things—that it pays to have a firm, smooth and continuous foundation for the pipe, that drift pins give a better fitting-up job than do bolts, that 100-lb. air pressure at the gun is essential for tight rivets, that backfilling with water in the trench secures better results than dry hand-tamping, that with a little extra care the pipe can be laid without damaging the protective coating. But the most important characteristic to be noted is that one of the old "standard" methods of construction is susceptible of constructive analysis and improvement. The procedure control which has been developed for welded pipe construction has repaid its cost many times. A similar set of modern rules is just as logical for riveted pipe construction and for all other engineering methods that are blindly following standardized precedents.

WHAT is the most economical size and shape for small-bore water tunnels? The answer is usually a personal opinion of an engineer or contractor, based on experience and custom rather than on scientific cost analysis. The size and shape of water tunnels are largely determined by supposed driving economies; only infrequently is carrying capacity the determining factor.

A tunnel must be large enough to accommodate narrow-gage tracks and cars, ventilation tubes, air, water and drainage pipes, and in these days usually also some type of mucking machine. If the bore is to be lined, the manipulation of forms, pneumatic placing machine and concrete trains must be considered. Should a tunnel size be kept down to a minimum just permitting operation, or is it more economical to enlarge the section, moving more muck but obtaining greater ease in manipulating equipment?

In the three New England water tunnel projects described in this issue, but one of the tunnel sizes was chosen for carrying capacity. The varying shapes and sizes of the others were selected for driving economy. One tunnel was too small to permit the use of mucking machines, all muck being loaded by hand. Is such procedure economically justifiable?

Why are some small bores circular, others horseshoe shaped, varying in ratios of width to height, and still others elliptical or nearly square? Is one type easier or more economical to drive than another? If so, why? A search of the literature of tunnel construction fails to answer these questions. There is a timely need for a discussion of small-bore tunnel construction based on a scientific cost analysis of varying sizes and sections.

Many-Purpose Water-Treatment Plant for Beverly Hills, California

Well Water Aerated, Softened, Filtered and Chlorinated for Removal of Hydrogen Sulphide, Hardness, Sulphur and Organisms—Novel Method of Combating Peculiarly Constituted Filter Mud Balls

FORCED to provide its own water supply or become a part of the encircling city of Los Angeles, the city of Beverly Hills, Calif., sank wells some 300 to 600 ft. within its own boundaries and built a 5-m.g.d. many-purpose treatment plant to free the water from several objectionable qualities. The well water has a hardness of 12 to 20 grains per gallon and gives off hydrogen sulphide up to 20 p.p.m. It contains particles of free sulphur and sulphides, with attendant beggiatoa, as also iron and manganese compounds, accompanied by crenothrix and manganothrix. The treatment finally adopted was aeration, lime treatment against hardness, mechanical filtration with coagulation for clarification and removal of bacteria, and chlorination, the latter not only to remove any bacteria left in the effluent but also, as experience showed to be needed, to cope with mud balls composed of sand manganese, lime and organic matter, the last of which gave rise to disagreeable odors that occurred when the filters were washed.

GENERAL VIEW OF BEVERLY HILLS PLANT
Tower conceals stack used in carrying off sulphur gases.

Briefly, the water, after aeration, is passed through two sets of chemical mixing tanks, each of four units, with a primary settling tank between and a much larger final settling basin beyond, and the filters still further on. Both the lime and alum doses are split, as explained later. Chlorine is applied to the final effluent, and also to the filter wash water. As described later, special architectural treatment was given to the building which houses the plant, since it is located on a boulevard.

Beverly Hills is a high-class residential city on the westerly side of Los Angeles and completely surrounded by that city. The smaller town was forced to develop a water supply of its own if it wished to preserve its civic independence. Since the Los Angeles city charter expressly forbids supplying water to territory outside the city limits, annexation would have been a prerequisite to obtaining water from the Los Angeles aqueduct.

Water in sufficient quantity was found to be available in subterranean basins beneath the southerly part of the city, but its mineral content was so high as to necessitate extensive treatment. The problem was attacked by first spending about $5,700 on a 70,000-g.p.d. experimental plant which was run on test for five months. In this plant processes were developed whereby it was possible to convert a highly turbid water with bad taste and strong odor to a clear, tasteless, odorless water with hardness reduced 50 per cent.

Based on the experimental data, a 5-m.g.d. treatment plant was designed and built with provision for expansion to 10 m.g.d. This plant went into service in May, 1928, and in the year's subsequent operation the methods of treatment have been modified to meet the particular needs of a highly mineralized water.

Despite confidence in the experimental work, it was realized that because of the high mineral content changes in the method of treatment originally prescribed might be necessary. Moreover, tests showed that water from the different wells varied widely in chemical and biological content, so that it would be necessary to have the ultimate plant as flexible as possible. In the plant layout, therefore, the arrangement of flumes and gates permit of water being routed in various ways by the use of temporary wooden structures. The result has been that in the modifications made during the year no concrete poured in the original construction had to be removed.

Experiments with various methods of aeration resulted in the selection of Sacramento-type spray nozzles set 4 ft. above a sloping floor. Best results were secured when the sprayed water trickled about ½ in. deep over the floor slab. This aeration takes place in a closed chamber from which the gas is carried off by a stack 130 ft. high, treated as a tower. A pressure oil burner in the base of the tower creates the necessary draft to carry off the fumes. No complaints from the neighborhood have yet been received. At first the plan was only to filter the water to get out the sulphides, free sulphur and iron, as well as the organic matter developed by the organisms feeding on these minerals. It seemed extravagant to soften the water in a community where the mean annual consumption is 225 gal. per capita per day (with summer months reaching 345 gal. and peak days 415 gal.). The tests showed, however, that a very desirable degree of softening could be had by an additional operating cost of less than 1c. per 100 cu.ft.

The lime aids in producing the best floc, gives longer filter runs and helps reduce the hardness from 40 to 50 per cent, depending on the quality of the raw water. (The average reduction since the plant has been in operation is 42 per cent.) The wash water was reduced, from the 5 per cent required when alum alone was used, to 2.66 per cent by using 8.56 gr. of lime with the 1.06 gr. of alum. (Averages over a nine-month operating period.)

The points of application of the chemical feed have been changed. The best locations were found to be one-half the lime dosage in the flume from the aerator

AERATION CHAMBER FOR REMOVAL OF H_2S GAS

Sacramento-type nozzles are used. Inclosure was necessary so gases could be collected and led off.

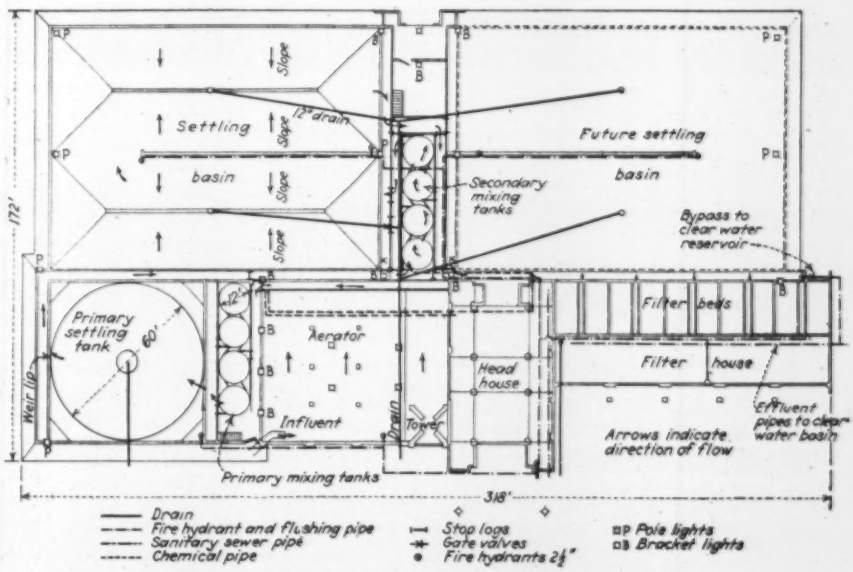
to the first set of mixing tanks and the other half into the first of these tanks. One-half the alum dosage goes into the second tank of the first series, being applied at about one-third the 20-ft. depth. The second half of the alum goes into the first of the second series of mixing tanks. This arrangement was judged the best on the basis of lime reaction and floc building as proved by the percentage of hardness reduction and the amount of wash water used.

Each tank in both the primary and secondary series is 12 ft. in diameter and 20 ft. deep, and is equipped with variable-speed mechanical agitators, working at 13 to 20 r.p.m. The retention time averages five minutes per tank. From the first series of mixing tanks the water flows to a primary settling tank, 60 ft. in diameter, with revolving sludge scrapers and with a retention time of one hour; then through the secondary mixing tanks and on to a 96x130-ft. sedimentation basin, 14 ft. deep, in two compartments, with a total 5-m.g. capacity and a retention period of about six hours. The settled water goes to five sand filters arranged in two half-sections, each 9x20 ft. in plan. The sand has an effective size of 0.40 mm. and a uniformity coefficient of 1.4. Underdrains are 2-in. seamless brass tubes, 9 in. c. to c., with $\frac{3}{8}$-in. holes 6 in. apart in a single row on the bottom.

Wash water for the filters is furnished by two 57,000-gal. tanks on the fourth floor of the building. Chlorination is provided for by two vacuum-type machines, one in the pipe gallery to treat the effluent and the other a portable device now being used just before filtration.

The primary reason for filtration was to rid the water of the microscopic particles of free sulphur and sulphides with their attending beggiatoa, and also the iron and manganese compounds with their crenothrix and manganothrix, respectively. In combating manganothrix in the sand filters it was discovered that very effective use could be made of chlorine. This came about as follows: Mud balls, in some cases as large as hens' eggs, developed in the filter beds and were not broken up by washing. Coupled with this was a highly disagreeable odor that occurred while washing filters. Analyses of the mud balls showed them to contain 80 per cent sand and 20 per cent soluble lime and organic matter. Of the latter, 0.3 per cent was iron and 0.1 was manganese. At this time chlorine was being applied at the rate of 0.5 p.p.m. of water entering the filter beds. This dosage was raised to 1 or 2 p.p.m. without getting more than a trace of residual chlorine in the effluent. Careful tests showed that an excessive amount of residual chlorine could be obtained through parts of the bed and none through other parts.

To combat this condition a treatment was prescribed to be applied to each filter separately as it was taken out of service for washing. After being washed in the usual way the standing water in the filter was chlorinated until it turned a dark brown color under the orthotolodin tests. The rewash valve was left open until the water from the bottom of the filter gave the same reaction, showing that the whole bed had been treated uniformly. The water was then left to stand 24 hours, after which the filter was drained and again washed in



PLAN SHOWING SEQUENCE OF WATER TREATMENT

Water routed through aerator, first chemical mixing tanks, primary settling tank with revolving sludge scrapers, second set of mixers, final settling basin, and filters.

the ordinary way. After one treatment of this sort not only did the bad odor and the organic formation on the sand beds disappear but the filter runs increased and practically all of the mud balls dissolved.

Three weeks after the first filter was so treated, mud balls and odor were again noticed. The filters were treated as before and after the second treatment only a very few small mud balls remained. Chlorine was applied by submerging the discharge hose of a portable chlorine injector in the water of the filter bed and dragging it around until there was a uniform distribution. Rough tests made by weighing the chlorine tank before and after treatment indicate that the quantity necessary was 15 to 20 lb. of chlorine per 1 m.g. of water.

In disassembling some of the valves and fittings, careful inspection was made to see whether the chlorine was attacking the metal. There were no indications of such action and it was believed that because the extra dosage of chlorine is in contact with the metal so short a period, the effect will be minor.

INTERIOR OF FILTER GALLERY
Pipe gallery is beneath this floor. Concrete arches are supported independently of filters.

Because the filtration plant is located in a residential district, rather novel architectural treatment was developed. The stack is so concealed by the tower that its function is not suspected—the escaping gases are invisible. All concrete surfaces were left just as when the forms were stripped and the Old Mission style was carried out by arched doorways and clay tiling.

Over the filters the roof structure is carried on hinged arch trusses. To avoid any effect on the truss supports that might result from settling under the heavy load on the filter beds, the trusses were carried outside the walls to flying buttresses leading down to independent foundations. The entire roof frame and slabs throughout the structure are of reinforced concrete.

The total cost of the plant, including equipment, was $240,000 and the operating cost, not including bond redemption and interest charges, totals 2.28c. per 100 cu.ft., made up of the following elements: alum, 0.14; chlorine, 0.07; lime, 1.03; other materials, labor and power, 1.04.

Prior to the construction of this water-treatment plant a census of bottled water consumption was made by pasting a questionnaire to water bills sent to consumers on the city's system. The result showed that 85 per cent of the consumers used bottled drinking water. A year later, after the new water-treatment plant had been in operation eight months, a similar census showed only 45 per cent of the consumers using bottled water. This reduction in bottled water cost to consumers exceeded the cost of plant operation. Many replies to the questionnaire indicated that the use of bottled water was being continued from force of habit or from adverse propaganda by bottled-water agents. It was believed that with a little effort the consumers would materially increase the use of the city supply for potable purposes.

TYPICAL MINERAL ANALYSES BEFORE AND AFTER TREATMENT
(Composite Sample, Typical Summer Month—July, 1928)

	Raw Water		Treated Water	
	P.P.M.	Gr. Per Gal.	P.P.M.	Gr. Per Gal.
Silica (SiO_2)	0	0	0	0
Calcium (Ca)	63	3.654	13	0.754
Magnesium (Mg.)	33	1.914	12	0.696
Sodium and potassium (Na and K)	145	8.410	150	8.700
Boron (B)	Present	.....	Present	
Carbonate (CO_3)	0	0	48	2.784
Bicarbonate (HCO_3)	439	25.462	110	6.380
Sulphate (SO_4)	45	2.610	50	2.900
Chloride (Cl)	144	8.352	132	7.656
Nitrate (NO_3)	0.6	0.035	1	0.058
Nitrite (NO_2)	0.2	0.012	0.01	0.000
Total residue at 180 C	732	42.456	528	30.624
Loss on ignition	77	4.466	58	3.364
Total salines	655	37.990	470	27.260
Total hardness as $CaCO_3$	293	16.994	82	4.756

The engineering and architectural work on the plant was done by Salisbury, Bradshaw & Taylor, consulting engineers, Los Angeles, who also supervised the construction and have general charge of operations and maintenance. Filter equipment was furnished by the California Filter Company. Carpenter Brothers, Inc., of Beverly Hills, executed the general contract.

Feeding Chlorine Through Long Pipe Proves Satisfactory

By August V. Graf
Chief Chemical Engineer, St. Louis Water Works, St. Louis, Mo.

CHLORINATION of the settled water at the Chain of Rocks plant of the St. Louis water-works was begun in October, 1927, the chemical being added at the same time as the secondary coagulant through four manually controlled vacuum chlorinators of the pedestal type located at the north end of the filter plant. At first the chlorine cylinders were connected to a manifold alongside the chlorinators, necessitating transportation of the cylinders from the unloading floor in the head house through the head house and filter plant, a distance of 800 ft.

Handling the cylinders entailed so much work that later a room was built on the unloading floor and six batteries of eight cylinders each were connected to manifolds, which in turn were connected to a ¾-in. galvanized pipe which conveyed the chemical to the chlorinators at the north end of the plant. This pipe runs through a pipe gallery where the temperature is always low. At first trouble was experienced with liquefaction of the chlorine in this long line. Whenever a new battery of cylinders was turned on the high pressure of the gas resulting from the low temperature caused the chlorine to be emitted from the control valve in spurts and the valve would soon clog. This was remedied by installing a reducing valve on the long line in the chlorine room and by maintaining a pressure of less than 100 lb. per sq.in. All trouble from liquefaction has been overcome, the chlorinators operating as well as if the cylinders were right beside them.

Tanks and Standpipes Designed for Conspicuous Locations

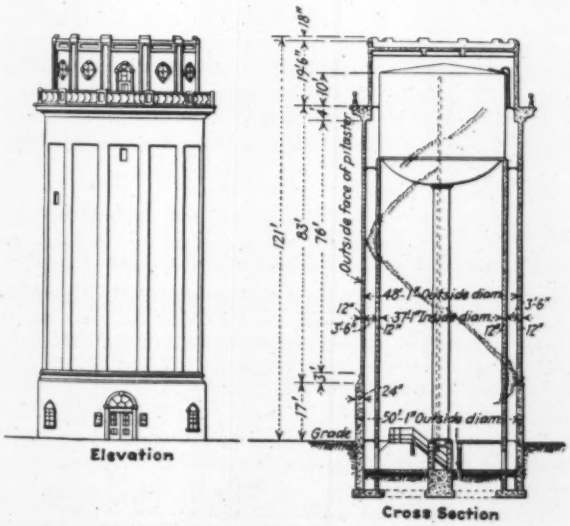
Treatment as Towers Used for High Tank in Grover Cleveland Park and for Standpipe at Woods Hole

HIGH TANKS and standpipes for the equalization of pressure in municipal water systems generally are of necessity conspicuous objects on the landscape. In many instances they have not added to the attractiveness of the region where they are located. In our issue of March 14, 1929, we described the unusually fine tanks at Cincinnati, where much ingenuity has been displayed in grouping large tanks. In the following articles two additional examples of such structures are given, one in a city park and the other in a high-class residential district. Both deserve close attention, for, as at Cincinnati, excellent architectural effects have been obtained. —EDITOR.

Grover Cleveland Tank and Tower, Buffalo Water-Works

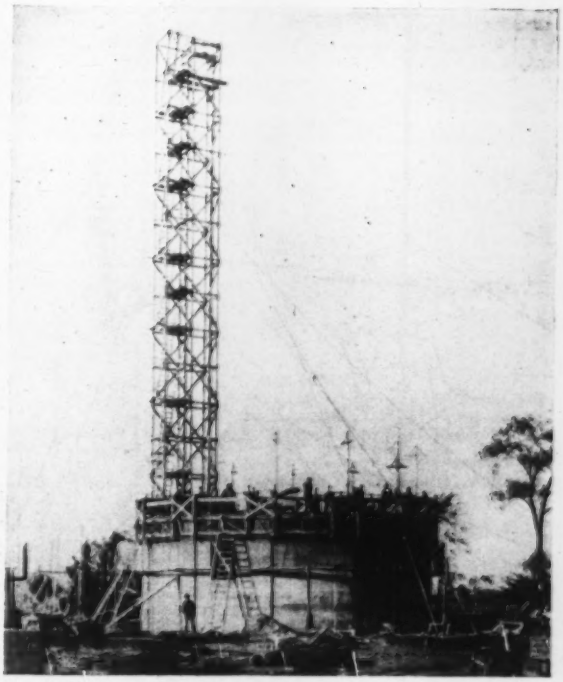
BY FREDERICK W. WANZEL
Structural Engineer, Buffalo, N. Y.

ONE tower supports and another incloses a new steel water tank located in Grover Cleveland Park, Buffalo, N. Y. The encircling tower is for architectural effect because of the location of the elevated tank. It is stepped in and railed in near its top, thus providing an observatory for those willing to climb 100 ft. for a view of city and lake. Below the landing is a cornice, and below it, in turn, pilasters extend to the enlarged base of the outer tower. Above, the cornice pilasters, in line with those below, extend to the top of the tank. The shorter pilasters protrude upward slightly, giving a battlemented effect. Winding stairs between the two towers give access to the observatory. To enhance still further the architectural effect, the aggregate in the concrete of the enlarged base is exposed, marble-faced artificial stone trimming has been used and the concrete is painted a buff color. Besides these unusual design elements, an interesting feature of the construction was



DETAILS OF BUFFALO TANK-TOWER

GROVER CLEVELAND TOWER-TANK, BUFFALO WATER-WORKS
Steel tank on concrete tower, both inclosed by similar tower.



BUFFALO WATER TOWER UNDER CONSTRUCTION
Inner and outer concrete shells poured continuously from top to bottom between movable forms from working platform.

the use of two sets of forms, one inside the other, lifted simultaneously; and the erection of the steel tank after the supporting and encircling towers had been built, the plates having been assembled in place.

Need for the elevated tank was caused by the rapid growth of the residential section of Buffalo, which by 1926 had reduced the pressure to a very low point. Governing conditions of design were: a maximum water head of 120 ft.; tank capacity, 0.25 m.g.; a monumental design; cost not over $85,000. An uninclosed steel tank and supporting steel tower were ruled out by the location in a park. The cost limit also ruled out brick or stone for the encircling tower. A circular concrete tower, with pilasters, was decided on as the most pleasing and economical structure for the outer tower that could be built within the appropriation, and concrete was also adopted to support the tank, the possible use of movable forms being a factor in each case. The decision as to tank support was not made until consideration had been given to steel legs, concrete columns and a bracket ring. It was found that the ring would not be good construction and that either the steel legs or the concrete columns would have to be erected after the outer shell had been poured, causing delay.

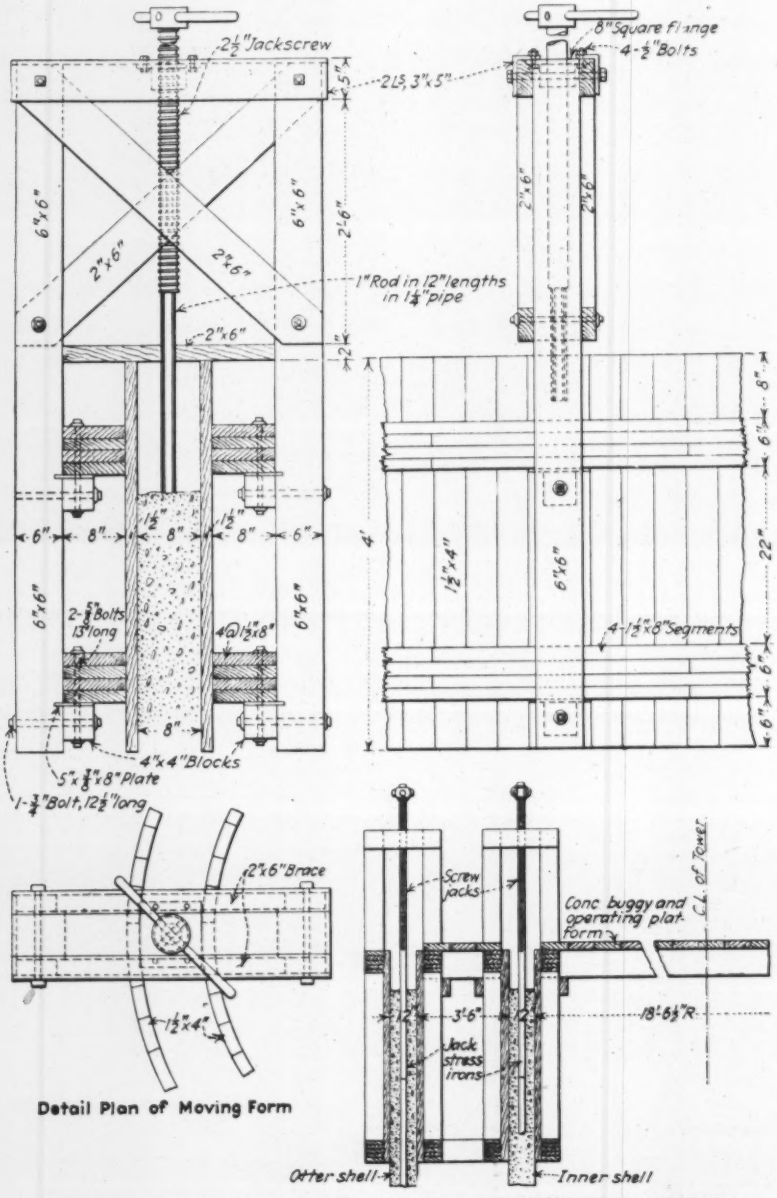
As a bearing for both shells, a common ring footing of concrete, on rock, is used. A concrete slab directly above the footing serves as a floor to the pump pit. At the other extreme, the tank is covered by a slab-and-beam roof. The spiral stairway is supported by the two shells and is lighted by a window at each landing. The main dimensions of the tank and two shells or towers are shown on the drawings, except that the pilasters are all 3 ft. wide and 4 in. deep, leaving 8 in. for the thickness of the shell between, down to the base.

The two sets of forms were made of 4-ft. wood staves. The resulting rings were suspended from the platform from which concrete was poured and tamped (see detail of forms and jacks). Both sets of forms were moved slowly upward until the cornice at the step-in was reached, the pouring being continuous. Progress ranged from 4 to 12 ft. in 24 hours, with an average of 8 ft. A crew of men was continually walking around the platform, from jack to jack, giving each jack a quarter turn. An elevator hoist supplied concrete to the working platform, from which the rings were lifted and the concrete tamped. Both platforms and rings were kept horizontal by a level permanently mounted on the platform.

The extra 12-in. thickness of the base of the outer shell or tower was obtained by pouring the concrete in fixed forms after the moving forms had cleared the base. The pilasters were formed by means of panel boxes of wood, 4 in. deep, fastened with lag screws to the inside of the outer staves. The lag screws were removed when the upper end of the pilasters were reached and the forms continued upward, leaving the panel boxes behind. The shell above the balcony or cornice was poured in fixed forms.

The aggregate in the base of the tower below the artificial stone belt course was exposed by the use of stone chisels and bush hammers. To give color to the concrete, a buff cement coating was applied in three coats, the first one thinned with turpentine at the rate of one pint per gallon. A 1:2:4 mix of concrete was used for both shells, except that for 4 ft. down from the tank bottom a richer mix was used for the inner shell. A chemical designed to give quick hardening was used in the mixing water.

The estimated cost of the tank and tower was $85,000. The actual cost was $77,071, of which $61,901 was for the concrete structure and $15,150 for



DETAILS OF FORMS AND OF JACKS FOR CONSTRUCTING BUFFALO WATER TOWER

Forms lifted by jack screws. Rods in 1-ft. sections extended through green concrete to support forms and platform.

the steel tank. The contractors were: concrete, Tifft Construction Company, Buffalo; tank, Pittsburgh-Des Moines Company, Pittsburgh, Pa. The structure built was designed by the writer, under the direction of Howard L. Beck, city architect. Arthur P. Skaer, district manager of the Kalman Steel Company, Buffalo, was consulting engineer on the concrete construction. The tank-tower was put into use July 1, 1927. Besides serving its primary purpose of providing better pressure in the territory it serves it has proved to be a point of interest to many of the visitors to the park.

* * *

Steel Standpipe Inclosed by Wall at Falmouth, Mass.

By Edward B. Richardson

Richardson & Gay, Consulting Engineers, Boston, Mass.

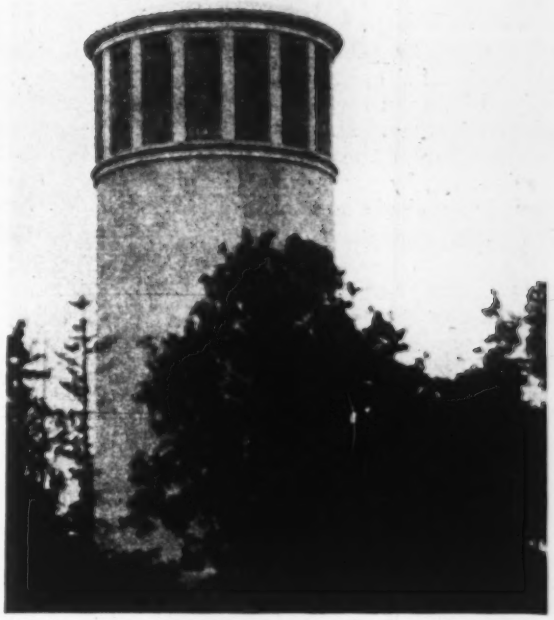
THE conspicuous location chosen for a new standpipe in the Woods Hole residential section of Falmouth, Mass., with visibility through a shore-and-water arc of 300 deg., led the water commissioners of the town to ask their consulting engineers to design a structure that would be ornamental as well as utilitarian. Their willingness to spend money for the amenities of the neighborhood is attested by the fact that the reinforced-concrete inclosing shell added $18,900 to the $12,300 cost of the steel standpipe with foundation and gate chamber.

The only decoration of the encircling wall was at the top. There, artificial stone was applied as a molded belt course, pilasters and a coping, with a surface color of sandstone. The panels were built with terra cotta run-of-kiln interlocking red tapestry tile, laid in cement mortar with wide joints, rough trowel struck. The architectural effect was further increased by the tapering of the intermediate portion of the wall, mentioned farther on, and by surface treatment. After the outer forms were removed the surface was mortar coated and rubbed with carborundum stone; thus uneven places were smoothed out. This rub was repeated as the staging came down to remove cement drippings; then a cement wash coat was applied. The lower 20 ft. of the concrete wall below the water table course was gone over with four-point tools driven by pneumatic hammers to expose the aggregate.

The steel standpipe inclosed by the wall is 26 ft. in diameter by 90 ft. high (capacity, 0.32 m.g.), with its top on a level with other standpipes in the water-works system.

The steel standpipe and the incasing masonry are independent of each other, except that the annular space between the two at the top is roofed by steel plates fastened rigidly to the standpipe and loosely to the inclosing wall. The foundation of the standpipe is a slab having a maximum thickness of 4 ft. on the outer ring and 2 ft. on the inside, the ring hooped with steel rods. In designing the foundation the weight of inclosing wall was considered in figuring resistance to overturning. The steel standpipe was completed so late in 1927 that work on the inclosing wall was postponed until the spring of 1928. The standpipe was used through the winter, no trouble developing from this incomplete loading of the foundation.

The reinforced-concrete masonry wall has interior stiffening vertical ribs and girth beams, with a clear annular space of 2 ft. between them and the steel standpipe. This space permits inspection, recalking and painting of the steelwork. Ventilating holes are provided in the wall, 20 ft. up from the foundation and near the top, with weep holes at bottom of base. All vent and weep holes are copper netted to prevent access of birds or animals.



ORNAMENTAL STEEL STANDPIPE AT WOODS HOLE

The shell of the encircling wall is 8 in. thick for the first 20 ft. from the foundation and 5 in. to the molding beneath the pilasters and panels. In the 50 ft. between the base and the molding beneath the panels, the walls taper 5 in. The reinforcing steel was kept 2½ in. from the outer face as a protection against access of moisture, rusting of the steel and cracking and spalling of the face of the shell. The approximate mix for the concrete was 1:2:4 in the shell and 1:2½:5 in the foundation, adjustment being made by water-cement ratio to obtain 3,000 lb. concrete for sake of density in the superstructure. For this portion only the contractor added 3 lb. of diatomaceous earth per bag of cement and an extra quart of water for the sake of a better job and ease of handling. There was 211 cu.yd. of concrete in the superstructure, averaging nearly 17 ft. per barrel of cement.

Although the fact that the steel standpipe in place and in use was an aid to the contractor, notably in the hoisting and bracing of forms for the concrete work, it interfered materially with the measurements for form location and diameter measurements, due to variations in plate thicknesses, the lap of plates and the projection of rivet heads.

Construction was carried on from an outside, built-up circular staging, with an elevator tower at one side. The concrete wall was poured in 5-ft. lifts, using steel forms on the outside and pans on the inside, both forms and pans being 5½ ft. high, to overlap on the lift just poured. The contractor built his pans from ⅞-in. pine, faced with black sheet iron, painted. These pans were too light but with additional strengthening on the job they served until the end.

For the outside the steel forms (four for the circumference of about 104 ft.) No. 12 steel was used, with $1\frac{3}{4}$x$1\frac{3}{4}$x$\frac{1}{4}$-in. girth and vertical angles, the latter spaced about 6 ft. apart except at end joints of the plates, where 2x$\frac{5}{8}$-in. flat iron strips were used. There were three of the girth angles, the top and bottom ones being 6 in. from the edge of plate and the third one midway between. Each of the four outer forms was suspended from two points, at approximate center of gravity lines, by wire rope extended up, with spreader beams, to a single differential chain hoist. The latter were hung from the top of the steel standpipe by hooks bearing on the top angle iron and the edge of the plates. These forms, like the pans, were too light, so they bulged out between the girth angles. To overcome this, there were used 3x4-in. timbers set vertically and drawn in tightly with wire rope fitted with turnbuckles. Because of the 5-in. taper in the intermediate 50 ft. of the wall the plate ends of the steel forms had to be cut off whenever they interfered with the end stiffening angles, while at other times the plates were overlapped to meet the decreased diameter of each lift.

Procedure at the start of work was to set up vertically 2x8-in. plank for back-of-rib forms, braced from the standpipe. The pans were then put in place between the plank and braced with face set off the vertical to meet taper of wall and the reinforcing steel placed. The outer forms were then set and the concrete was poured. Next day the steel forms and pans were moved up. Three 5-ft. pours a week was the best record made.

In the upper part of the wall the artificial stone fitted with iron dogs was set and wired to the reinforcing steel for the concrete backing before the concrete was poured, thus serving as outer forms and uniting with the concrete. The joints were wedged and the face openings between the stone were calked with paper to prevent concrete grout working out and for later pointing with mortar matching the stonework.

Contract amounts for the double structure were:

Steel standpipe erected	$9,970	
Concrete foundation, with gate chambers and rough grading	2,344	
		$12,314
Concrete shell		18,871
		$31,185

This total includes no pipe connections. Allowing 12 per cent for engineering and incidentals brings the cost to just under $35,000, or about $11.65 per million gallons of water capacity.

The contractor for the steel standpipe was the Pittsburgh-Des Moines Steel Company; for foundation and shell Eldon Smith, (Allston) Boston. The consulting engineers were Richardson & Gay, Boston, with J. R. Worcester & Company, Boston, designing the reinforced-concrete details for them.

Buggy Gives Painters Easy Access to Small Steel Water Pipes

By O. G. Goldman

Assistant Superintendent, City Distribution Department, Spring Valley Water Company, San Francisco, Calif.

THROUGH the use of rubber-tired buggies on which a man can lie and propel himself in a pipe, the Spring Valley Water Company, of San Francisco, has solved the difficult problem of completing the inside protecting paint coat at the joints of steel water pipes from 16 to 36 in. in diameter. This problem, which is particularly difficult where it is necessary to do the joint painting several hundred feet behind the end of the line in order not to delay the riveting or welding process, prompted the design and use of the buggy shown in the accompanying illustration.

In pipe lines of 36-in. diameter or larger it is possible for men to crawl or walk into the pipe to do this painting. In the smaller sizes down to a minimum of 16-in. pipe, where it is difficult or impossible to crawl even a few lengths, the buggy has been used successfully to enter pipe lines as far as 1,000 ft.

The buggy consists of two axles about 4 ft. apart and a light body of boards. The axles are bent to give a clearance of about 1 in. at the bottom of the pipe and are equipped with rubber-tired wheels to prevent injury to the inside paint coat. Different sizes of pipe lines require buggies with different axle curvatures in order to maintain the bottom clearance without losing headroom.

Lying on this buggy a man can propel himself with his feet without difficulty while carrying painting equipment in his hands. No ropes are used, the men moving entirely by their own efforts and pipes on grades of about 20 per cent have been successfully traversed. Small men have worked successfully in 16-in. pipe, although this is about the smallest size possible for the practical use of the buggy. As a safety measure, men are always sent into the pipe in pairs, each on a buggy, using flashlights for illumination, the first man wire-brushing the joints and the second doing the painting. The grades of most of the San Francisco streets are such that the air valve and blowoff openings create sufficient draft to allow men to remain in the pipe for hours without discomfort.

BUGGY USED IN PAINTING INSIDE OF PIPE JOINTS ON 20-IN. LINE

Water Consumption Varies With Standards of Living and Fluctuations in Industrial Conditions

Per Capita Figures for 44 American and European Cities, 1907 to 1927, Show Living Standard Chief Cause of Higher Consumption Here Than Abroad and That Yearly Curve Varies With Industrial Conditions

By Abel Wolman

Chief Engineer, Maryland State Board of Health; Editor, Journal American Water Works Association

INTERPRETATION of water-supply consumption figures in a single community requires complete familiarity with all of the details of local municipal administrative policies. The extension of such an interpretation of similar figures to a comparison between communities in a single country increases the opportunity for error. Comparisons, in turn, between the figures for municipalities in different countries take on the aspect of danger. The temptation is frequently great, however, to determine whether any general principles or laws may be isolated from such data, even though no undue emphasis is laid upon the conclusions. Although the changes in water-consumption figures have been the bases of innumerable studies, they still offer opportunities for review which may lead to conclusions helpful to the water-works engineer, the municipal official and the social investigator in studies which they may undertake.

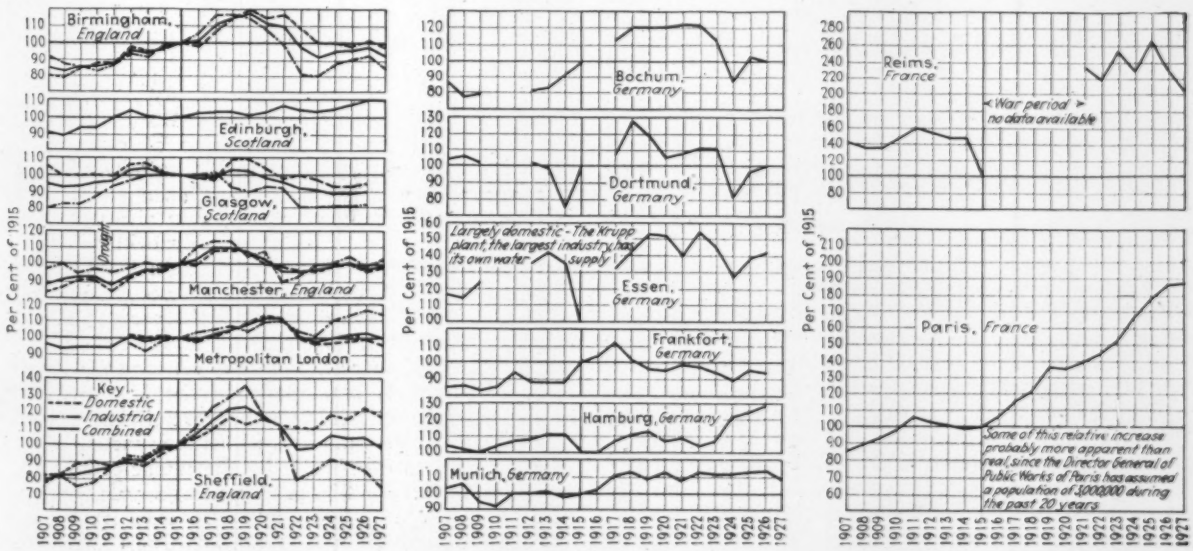
Use of water tends to rise with industrial prosperity and fall with industrial depression.

Per capita domestic use in United States is two or three times that abroad, due largely if not wholly to higher standard of living in America.

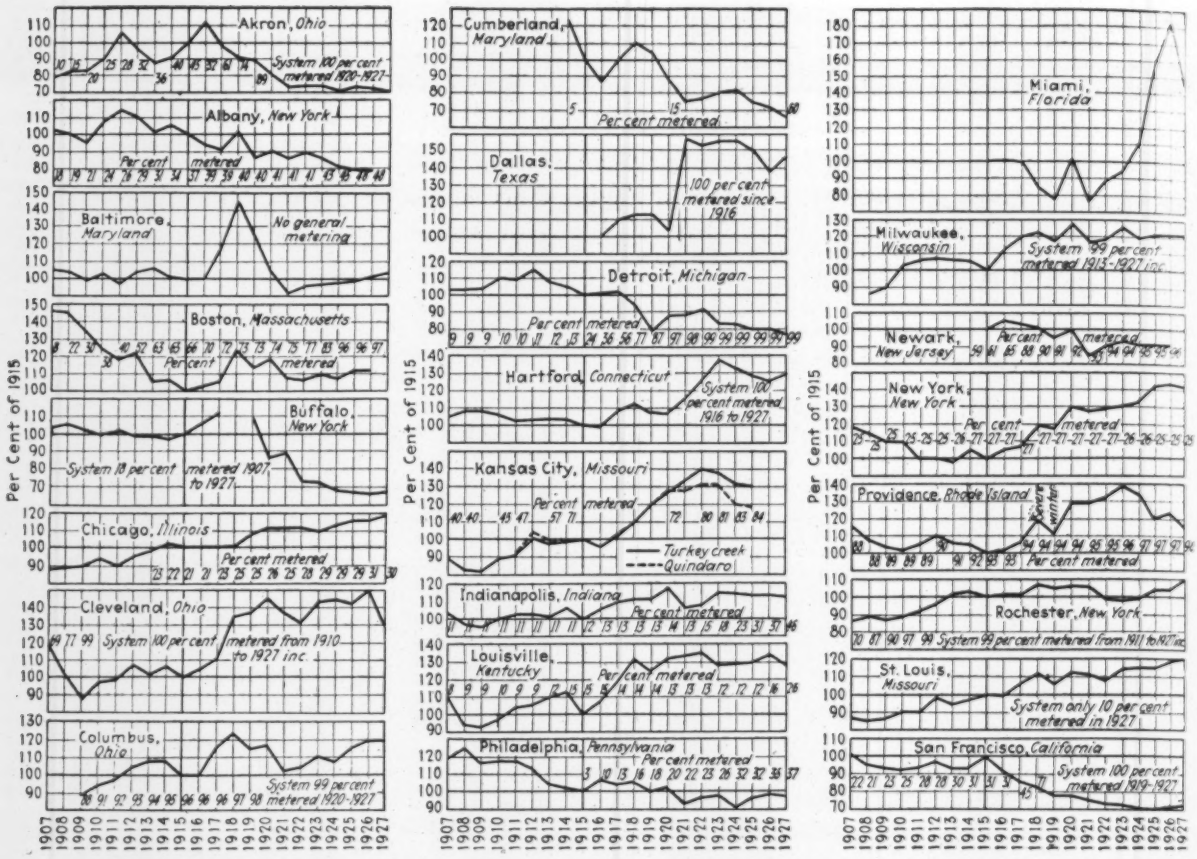
In forecasting water-supply requirements consideration should be given to demand for sanitary conveniences and to economic status of the individuals making up each community.

Per capita water consumption is affected by varied and numerous factors. The use of meters, restrictions upon waste, industrial demands, growth of population, water rates, character and availability of sources of supply, extent of purification required and the sanitary standard of living, all influence in varying degrees, but in significant amounts, the quantities of water used per person daily. Most of these factors have been carefully reviewed in the literature. Although there are differences of opinion as to the magnitude of influence of many of these, there is general agreement on the fact of influence. Perhaps the least amount of study has been devoted to the effect of standard of living upon water consumption. That this effect may be significant has been pointed out from time to time by water-works investigators. Its quantitative evaluation has rarely been made. A brief analysis of this factor is the subject of this article.

The material upon which this study is based has been collected from municipalities in the United States, Great Britain, France, Germany, Holland, Spain, Italy and Australia. The data have been gathered more or less at random, to avoid undue selection of material. The figures, the writer is well aware, represent a wide range


Per Cent of 1915
Birmingham, England
Edinburgh, Scotland
Glasgow, Scotland
Drought
Manchester, England
Metropolitan London
Key
Domestic
Industrial
Combined
Sheffield, England
Per Cent of 1915
Bochum, Germany
Dortmund, Germany
Largely domestic - The Krupp plant, the largest industry, has its own water supply
Essen, Germany
Frankfort, Germany
Hamburg, Germany
Munich, Germany
Reims, France
War period - no data available
Per Cent of 1915
Paris, France
Some of this relative increase probably more apparent than real, since the Director General of Public Works of Paris has assumed a population of 3,000,000 during the past 20 years
1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927

RELATIVE CHANGES IN DAILY PER CAPITA WATER CONSUMPTION IN SIX ENGLISH AND SCOTCH, SIX GERMAN AND TWO FRENCH CITIES, 1907-27
Variations from 1915 figures taken as 100.



RELATIVE CHANGES IN DAILY PER CAPITA WATER CONSUMPTION IN 24 AMERICAN CITIES, 1907-27
Variations from 1915 figures taken as 100.

of accuracy and an exceedingly wide distribution of conditions. Inasmuch, however, as he is seeking for the appearance of only general trends, they may be used with profit. No attempt will be made to estimate to the decimal point the possible or probable influence of standard of living upon per capita water consumption. If general influences appear, this fact of itself is important. An effort has been made to take account of the differences in practice in separation of domestic from industrial water consumption, in the use of meters, in other forms of artificial control of usage and in comparisons between the sanitary standards in countries for which data are available.

Relative Changes in Per Capita Consumption

The first questions confronting the investigator in this field are: What have been the relative changes in per capita water consumption in long periods of time, and have these changes been correlated in any fashion with prosperity or other measures of standard of living? For such comparisons we are not concerned with the absolute per capita consumption, since the time trend in individual communities in different countries is the significant characteristic. Have there been any well-defined changes from year to year in the proportionate per capita consumption of water, independent of the use of meters, the cost of water, the industrial consumption and other contributing factors? The accompanying diagrams demonstrate that such changes have taken place during the past twenty years. The relative changes in per capita consumption have been plotted, using the figures for 1915 as an assumed base value of 100. The figures for all the other years have been calculated as percentages in excess or in deficiency of the 1915 assumed value of 100. The year 1915 was chosen as the base, because it was during the war period, at which time the low level of per capita consumption was assumed to have been reached. In some instances this is not the case. In Dortmund, Germany, for example, heavy war industrial operations account for the deviation from the assumption. These figures show that definite fluctuations in per capita water consumption have occurred during the last twenty years in practically all the municipalities. These fluctuations have been independent of the percentages of consumption which are metered. In other words, certain influences have been active in creating wide changes in water consumption in the same community in different years. Practically all of the cities show a drop in per capita water consumption in the post-war depression periods of 1921 to 1923. Whether or not this decline, preceded by similarly well-defined increases in per capita consumption immediately following the close of the war, is entirely due to changes in domestic consumption is difficult to determine, particularly in the United States. In this country practically no differentiation of total per capita water consumption, as between industrial and domestic uses, is ever made by the municipalities. In many instances, also, large domestic consumers have their own private water supplies, so that comparisons between American cities should ordinarily be interpreted with caution. In Great Britain, however, the water-consumption figures are frequently kept separate, so that we may obtain from these data some impression

as to whether the increases and declines in per capita water consumption during periods of industrial prosperity and depression are largely caused by industrial rather than by domestic use. In general, it may be seen that the changes in domestic per capita consumption follow very closely the trend of per capita consumption calculated upon the basis of industrial use alone. The fact that domestic consumers are all unmetered in these British supplies does not militate against the validity of these conclusions. This is likewise illustrated by the

TABLE I—DAILY PER CAPITA WATER CONSUMPTION, BERLIN, GERMANY

Year	U. S. Gal.	Year	U. S. Gal.	Year	U. S. Gal.
1922	32.1	1924	29.8	1926	35.3
1923	28.2	1925	35.3	1927	37.8

per capita changes in Essen, Germany, in which the figures used represent almost entirely domestic consumption. The post-war depressions illustrated in 1921 and again in 1924 in Essen are duplicated by the comparison for Dortmund and Bochum, Germany, both of which contain a considerable proportion of industrial users.

These declines in per capita *domestic* consumption, simultaneously with changes in industrial use, are especially interesting, in that it is frequently assumed that changes in per capita total consumption are due almost entirely to changes in industrial rather than in domestic use. From the foreign data here given, however, it is clear that domestic consumption, barring a degree of lag, drops simultaneously with and almost to the same degree as per capita industrial use, due perhaps to the fact that the domestic consumer, in periods of economic depression, uses less water either in the attempt to save on meter charges, to delay the installation of sanitary equipment, or because of a gradual change in his domestic standard of living.

A similar trend has been noted in this country in the use of electric power, although in this commodity per capita use usually begins to decline somewhat in advance of the actual industrial depression and begins to rise in advance of industrial prosperity.

Similarly, non-industrial changes presumably due to periods of prosperity and improved standards of living are quite well demonstrated by the relative per capita figures for Miami, Fla. Although limited figures are available for per capita water use in Berlin, Germany, they give further confirmation (Table I) of the great influence of the industrial depression of 1923 and 1924 on per capita consumption. The experience in the French cities is similar.

It is pertinent to point out that the post-war changes in per capita water consumption in American cities reflect for the most part the industrial situations, whether the supplies are metered or unmetered. It is apparent, however, in reviewing the figures from 1907 to 1915, that with the introduction of meters in the periods prior to the war significant reductions in per capita use resulted. In most instances this influence appears to be less significant than the artificial effects engendered by industrial prosperity and depression. Perhaps the most significant controlling feature apparent in the changes is that of water shortage. The reader will note from the figures that a drought or inaccessibility of new sources of supply are much more profound in their regulation of per capita use than most other characteristics of fiscal, engineering or social practice. This is well illustrated in the experience of San Francisco, Calif.

In such cities as Buffalo, where strenuous efforts at curtailment of water waste, without the introduction of meters, have been made in recent years, relative water-consumption figures have declined a great deal. In such instances the effect of industrial cycles has been quite well masked.

The trend of per capita water-consumption figures for New York City are of special interest. More detailed data (Table II) are available for the period 1910 to 1926, both inclusive, than can be given for the other cities considered in this article. W. W. Brush, chief engineer of the Department of Water Supply, Gas and Electricity of New York City, makes the following pertinent comments upon the material (personal communication):

The industrial use reached a per capita minimum in 1917, due presumably to war conditions, and reached a maximum in 1926, due probably to the improved business conditions throughout the country, which affect New York City very definitely. The per capita demand for other than the metered supply showed a mini-

TABLE II—PER CAPITA WATER CONSUMPTION IN NEW YORK CITY—MUNICIPAL SYSTEM*
U. S. Gallons Per Day

Year	Business and Industrial	Shipping, Building and Misc.	Domestic and Public Use, Meter Slippage and Waste	Total Use and Waste	Estimated Saving Made by House-to-House Inspections	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	
1910	30.2	1.2	79.1	110.5	0.0	Normal conditions
1911	27.0	1.2	72.9	101.1	9.4	Shortage of Croton water
1912	27.4	1.3	72.4	101.1	6.0	Conservation of supplies pending introduction of Catskill water
1913	27.4	1.0	69.8	98.2	5.5	.....
1914	27.2	1.1	77.5	105.8	3.6	.....
1915	25.8	1.0	74.6	101.4	4.0	.....
1916	26.2	1.1	78.9	106.2	4.2	.....
1917	24.2	0.8	82.7	107.7	4.1	Catskill supply introduced
1918	29.0	0.5	90.5	120.0	3.4	See footnote†
1919	29.7	0.8	88.3	118.8	3.9	.....
1920	31.5	1.0	98.5	131.0	2.1	Increase partly due to abnormally cold winter 1919–20
1921	31.2	1.0	96.9	129.1	1.1	Normal conditions
1922	31.3	1.6	97.1	130.0	0.1	Normal conditions
1923	34.4	2.0	95.8	132.2	0.8	Prosperous busin ss conditions. Building activity
1924	34.8	2.4	96.9	134.1	4.3	Prosperous business conditions. Building activity
1925	37.0	2.8	103.5	143.3	3.4	Prosperous business conditions. Building activity (lavish use during hot summer)
1926	38.3	2.9	103.2	144.4	4.3	Prosperous business conditions. Building activity (lavish use during hot summer)

(2) All business and industrial consumption is metered and figures in this column represent actual use of water for this purpose as measured by meter.
(3) Water supplied for use on vessels; in building construction; through hose and for other miscellaneous purposes. Based on revenue.
(4) Figures in this column = Col. 5 — (Col. 2 + Col. 3).
*A small percentage of the population is served by private companies.
†Increase due to industrial activities resulting from war demands and more liberal use of water and higher pressures following the introduction of Catskill water.

TABLE III—PER CAPITA WATER CONSUMPTION AND PER CENT OF SERVICES METERED IN 24 AMERICAN CITIES, 1907-1927, INCLUSIVE

City		1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Akron, Ohio	A	92.7	95.7	97.0	105.5	124.3	112.8	103.3	106.8	117.2	131.3	114.6	106.8	104.0	93.2	85.7	86.4	86.8	83.0	87.0	85.4	81.8
	B	10.0	15.0	20.0	25.0	28.0	32.0	36.0	40.0	45.0	52.0	61.0	74.0	89.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Albany, N. Y.	A	214.0	208.0	198.0	223.0	238.0	235.0	211.0	219.0	208.0	195.0	190.0	210.0	179.0	187.0	179.0	185.0	180.0	169.0	16.5	165.0	
Baltimore, Md.	A	130.0	129.0	123.0	128.0	120.0	129.0	131.0	125.0	124.0	124.0	147.0	180.0	155.0	129.0	114.0	119.0	120.0	122.0	123.0	126.0	129.0
Boston, Mass.	A	129.0	128.0	119.0	109.0	104.0	107.0	93.0	94.0	88.0	91.0	93.0	109.0	100.0	105.0	95.0	94.0	97.0	95.0	98.0	98.0	
	B	18.0	22.0	30.0	38.0	40.0	52.0	58.0	63.0	66.0	70.0	72.0	73.0	73.0	74.0	75.0	77.0	83.0	96.0	96.0	97.0	
Buffalo, N. Y.	A	323.0	322.0	330.0	321.0	313.0	317.0	310.0	309.0	302.0	312.0	329.0	350.0	342.0	267.0	278.0	228.0	224.0	213.0	208.0	204.7	207.2
Chicago, Ill	A	220.1	221.7	222.0	234.2	224.2	235.1	243.6	254.2	248.0	249.0	249.0	251.0	264.4	276.0	276.0	274.6	270.7	277.8	286.2	285.5	292.8
	B							22.5	21.9	20.8	21.1	23.1	25.2	25.3	25.6	25.0	28.0	28.8	28.7	29.2	31.2	30.2
Cleveland, Ohio	A	118.2	100.9	87.2	96.1	98.0	106.3	100.7	106.3	99.2	104.2	110.1	134.3	135.8	144.2	135.6	130.3	141.7	142.8	140.6	148.8	127.9
	B	68.6	76.7	99.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Columbus, Ohio	A			71.4	75.6	78.0	83.5	87.3	87.5	80.5	87.1	92.4	99.7	92.7	94.1	82.3	83.6	88.5	85.9	92.8	96.1	96.2
	B			88.2	91.3	92.3	93.4	94.3	94.9	95.4	96.1	96.4	96.6	96.8	97.9	98.9	98.9	98.9	99.0	99.0	99.0	99.1
Cumberland, Md.	A								326.5	266.6	232.4	266.5	292.4	277.5	234.5	200.8	204.6	213.2	217.6	199.9	190.9	178.9
	B								123.0	100.0	87.0	100.0	110.0	104.0	88.0	75.0	77.0	80.0	82.0	75.0	72.0	67.0
Dallas, Tex.	A										40.0	44.0	45.0	45.0	41.0	63.0	61.0	62.5	62.5	60.5	55.2	58.7
Detroit, Mich.	A	167.0	167.0	168.0	178.0	177.0	187.0	175.0	171.0	162.0	163.0	166.0	152.0	128.0	143.0	143.0	148.0	135.0	134.0	130.0	131.0	126.0
	B	8.7	9.0	9.0	10.0	10.0	11.0	12.4	12.8	23.6	35.6	56.0	76.8	86.9	97.4	98.1	98.5	98.8	98.9	99.1	99.1	99.1
Hartford, Conn.	A	70.2	72.2	71.6	70.4	68.1	68.5	69.3	69.5	66.6	65.6	71.3	74.5	72.0	71.2	77.9	83.6	91.8	88.8	85.6	83.6	
	B	98.1	98.4	98.7	98.9	98.8	98.6	98.8	98.4	98.2	98.5	97.8	97.8	97.7	97.4	96.8	96.7	96.6	96.4	96.4	96.1	
Indianapolis, Ind.	A	83.0	78.0	76.0	80.5	81.5	81.5	81.3	84.7	79.4	83.8	87.3	88.5	87.9	94.0	84.3	86.2	91.4	90.6	90.1	90.1	89.3
	B	10.8	11.0	11.0	11.1	10.9	10.6	10.7	11.4	11.8	12.5	13.2	12.9	13.2	13.6	13.4	15.0	17.9	22.9	30.7	36.8	45.8
Kansas City, Mo.	A	85.0	80.0	82.0	85.0	87.0	97.0	94.0	95.0	96.0	92.0	98.0	105.0	114.0	122.0	128.0	134.2	132.5	125.7	124.5		
	B	39.5	40.3		44.5	46.5		57.0	71.0						72.0		80.1	81.1	82.5	82.4		
Louisville, Ky.	A	115.0	99.0	98.0	102.0	109.0	111.0	116.0	119.0	105.0	112.0	124.0	139.0	131.0	139.0	140.0	142.0	134.0	135.0	137.0	141.0	134.0
	B	8.1	8.6	9.2	9.5	8.7	8.9	12.1	14.8	14.5	14.6	14.0	13.7	13.5	13.3	13.1	12.7	12.4	12.1	11.6	16.2	26.2
Miami, Fla.	A									116.5	117.0	115.8	99.0	90.5	118.0	88.5	103.3	109.1	129.0	183.5	214.9	169.7
Milwaukee, Wis.	A		91.0	95.0	109.0	111.9	113.2	111.5	110.2	105.4	118.0	125.3	129.0	123.8	133.8	122.2	124.5	132.0	125.4	128.0	127.8	127.8
	B		98.1	97.5	97.9	98.3	98.8	99.3	99.3	99.0	99.0	99.0	99.0	99.0	99.0	98.7	98.7	98.7	98.7	98.7	98.8	98.8
Newark, N. J.	A								42.3	41.7	46.5	45.6	47.8	43.4	45.7	39.9	42.6	44.7	45.0	45.5	46.1	
	B								58.8	60.6	64.8	88.1	89.9	90.6	92.1	92.7	93.8	94.3	95.2	95.2	95.6	
New York, N. Y.	A	118.9	116.0	110.7	110.7	101.5	101.8	98.9	106.0	101.1	106.6	108.3	120.1	118.4	130.2	128.5	129.4	131.7	133.8	143.1	144.1	142.0
	B	25.0	25.0	25.0	25.0	25.0	25.3	26.4	26.7	26.5	26.5	27.0	27.1	27.2	27.2	27.2	26.8	26.3	25.6	24.8	24.8	24.8
Philadelphia, Pa.	A	206.0	216.0	201.0	203.0	202.0	195.0	180.0	176.0	173.0	183.0	179.0	181.0	173.0	175.0	161.0	166.0	168.0	157.0	165.0	169.0	168.0
	B								1.0	3.0	10.0	13.0	16.0	18.0	20.0	22.0	23.0	26.0	32.0	32.0	35.0	37.0
Providence, R. I.	A	72.0	67.0	64.0	63.0	65.0	68.0	66.0	65.0	62.0	63.0	66.0	74.0	69.0	80.0	80.0	82.0	86.0	83.0	75.0	76.0	71.0
	B	88.0	88.0	89.0	89.0	89.0	90.0	91.0	92.0	93.0	93.0	94.0	94.0	94.0	94.0	95.0	95.0	96.0	97.0	97.0	97.0	97.5
Rochester, N. Y.	A	79.0	80.0	78.5	80.8	83.4	86.9	92.4	93.4	90.3	91.4	91.6	96.7	94.6	95.7	96.0	89.6	88.6	89.3	94.0	93.9	99.5
	B	69.7	86.6	90.0	97.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0
San Francisco, Calif.	A	93.0	87.0	86.0	85.0	86.0	89.0	86.0	86.0	92.0	85.0	79.0	76.0	72.0	72.0	70.0	67.0	67.0	65.0	64.0	65.0	66.0
	B	21.3	23.2	25.0	27.5	28.3	29.5	31.0	31.0	31.0	45.0	71.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
St. Louis, Mo.	A	105.8	103.7	104.6	109.7	109.4	118.6	114.4	117.4	121.5	120.0	129.3	135.5	129.3	135.1	134.5	131.7	138.9	139.5	139.4	145.1	145.4
Average		134.6	127.4	124.2	128.5	129.1	132.2	128.2	134.7	128.1	125.5	130.1	137.3	130.9	130.2	125.1	124.9	126.5	125.4	127.7	129.7	132.2
Per cent (1915)		105.0	99.0	97.0	100.0	101.0	103.0	100.0	105.0	*100.0*	98.0	102.0	107.0	102.0	102.0	98.0	98.0	99.0	98.0	100.0	101.0	103.0

A—Total water use per capita per day, in U. S. gallons.
B—Per cent of services metered.

mum in 1913, and was near this minimum from 1911 through 1917. The low consumption in 1917 was probably due to the war. For the other years it was due to the total supply for the city being hardly adequate for the demand, resulting in pressure reduction to curtail consumption and waste and house-to-house inspection from time to time in the different boroughs to reduce waste. With the introduction of the Catskill supply in 1917 the residents of New York City believed that there was an ample supply available, and the pressure throughout the city was generally increased. After the war the very large number of new buildings erected equipped with modern plumbing, the general rise in the economic condition of the people and the general adequacy of the water supply to meet the demand, reducing the amount of house-to-house inspection, are the probable causes for the increase in per capita consumption that is noted since 1918.

In 1920 the unusual rise in the per capita consumption is very probably in part due to the abnormally cold winter weather of 1919-20. Again in 1925, the weather was partly responsible for the unusual rise in per capita consumption, due to an unusually hot summer.

To summarize the concepts presented thus far in this discussion, the composite per capita figures are shown by curves for the cities in Germany, Great Britain and the United States. The figures used are simple arithmetic averages of the average per capita water uses for all the cities. Although not completely adequate statistically, this method results in the development of a composite trend which confirms the thesis already presented. The composite data for France are not included, owing to the absence of sufficiently complete information during the twenty-year period.

Absolute Consumptions of Water Per Capita Per Day

Tables III to VI present detailed data as to water uses in the various municipalities under discussion during the past twenty years. These figures demonstrate the extremely wide variations in actual water use per person per day in the various countries. The particularly important feature of the data in Table IV is the predominatingly high values for water use in the cities of the United States. It is frequently postulated that per capita water use in the United States is not only high but is excessive and probably represents an unduly wasteful practice of the American public. Although this charge is probably true, in so far as total per capita values in excess of 100 g.d. are concerned, there is considerable doubt as to whether the total consumptions approaching a maximum of 100 gal. actually represent wasteful uses. The per capita figures for the United States are generally two to three times as high as those for foreign countries. Additional data for comparison

TABLE IV—PER CAPITA WATER CONSUMPTION IN BRITISH AND SCOTCH CITIES, 1907 TO 1927, INCLUSIVE
U. S. Gallons Per Capita Per Day

City	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Birmingham, England	28.5	27.8	28.6	28.8	30.6	32.3	31.5	32.8	33.5	34.1	37.2	38.7	39.5	37.7	36.9	32.9	30.9	31.9	32.2	32.9	31.2
Edinburgh, Scotland	48.3	50.8	50.8	54.5	56.2	54.9	54.0	54.3	55.1	55.9	55.9	54.6	55.3	57.9	56.6	55.6	56.6	58.2	59.6	59.7	
Glasgow, Scotland	72.6	71.2	71.8	73.4	74.2	78.4	79.7	77.2	76.3	75.1	75.6	78.5	78.0	75.3	73.2	70.6	69.3	67.5	67.8	68.8	
London, England	41.7	40.2	40.8	40.8	40.5	43.7	42.4	43.3	43.2	42.9	44.2	45.3	46.8	48.3	48.1	43.8	42.3	43.3	44.1	44.7	43.4
Manchester, England	37.6	39.1	39.7	39.8	37.9	40.4	41.7	41.5	42.8	44.2	47.2	47.0	45.7	44.2	40.9	41.0	41.5	42.6	43.4	41.7	42.3
Sheffield, England	26.9	27.9	28.4	28.8	29.6	31.2	30.8	32.9	34.0	36.4	39.4	41.5	41.8	39.7	38.1	33.1	33.4	36.1	35.4	36.1	33.3
Average	42.6	42.8	43.4	44.4	44.8	46.8	46.7	47.0	47.5	48.2	49.9	50.9	51.2	50.6	49.0	46.2	45.7	46.6	47.1	47.3	37.6
Per cent (1915)	90.0	90.0	91.0	93.0	94.0	99.0	98.0	99.0	*100.0*	101.0	105.0	107.0	108.0	107.0	103.0	97.0	96.0	98.0	99.0	100.0	*98.0

*The 1915 average for these four cities only was used in obtaining this percentage.

TABLE V—PER CAPITA WATER CONSUMPTION IN SIX GERMAN CITIES, 1907 TO 1927, INCLUSIVE
U. S. Gallons Per Capita Per Day

City	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Bochum	75.7	67.2	69.5			70.7	72.5	80.0	87.5		98.2	105.0	105.2	104.7	105.7	105.5	98.0	75.2	90.2	87.2	
Dortmund	64.2	66.6	63.0			63.2	61.5	46.2	62.0		66.2	79.2	73.5	65.2	67.2	69.0	69.2	50.0	60.0	62.0	
Essen	39.2	38.7	42.0			45.2	47.5	45.7	33.5		44.2	47.5	51.2	51.0	46.5	51.5	48.5	42.2	46.2	47.2	
Frankfurt	39.5	40.0	38.5	39.5	43.2	40.7	41.0	40.5	46.2	48.2	51.7	47.0	44.2	44.0	45.7	45.2	43.5	41.2	43.7	43.5	
Hamburg	40.0	37.5	35.0	35.0	36.2	36.2	36.2	36.2	32.5	32.5	33.7	36.2	37.5	32.5	32.5	31.5	32.5	33.7	36.2	37.0	37.0
Munich	58.0	59.7	53.7	52.0	56.2	56.7	57.2	55.2	56.5	58.0	62.5	64.0	61.5	61.0	63.7	63.2	63.0	63.7	64.5	61.7	
Average	52.8	51.5	50.3	42.2	45.2	52.1	52.7	50.5	53.0	46.2	59.4	63.2	62.2	59.7	60.2	61.0	59.1	51.0	56.8	56.4	
Per cent (1915)	100.0	97.0	95.0	*94.0	*100.0	98.0	99.0	95.0	100.0	*102.0	112.0	119.0	117.0	113.0	114.0	115.0	112.0	96.0	107.0	106.0	

*The 1915 average for the three cities only was used in obtaining this percentage.

TABLE VI—PER CAPITA WATER CONSUMPTION IN TWO FRENCH CITIES, 1907 TO 1927, INCLUSIVE
U. S. Gallons Per Capita Per Day

City	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
Paris	21.5	22.5	23.4	24.7	26.8	25.9	25.5	25.1	25.2	26.7	29.0	30.6	34.4	34.1	35.1	36.3	38.4	41.8	44.9	46.9	47.2
Reims	24.0	23.0	23.0	25.0	27.0	26.0	25.0	25.0	17.0	No figures available					40.0	37.0	43.0	39.0	45.0	39.0	34.0

TABLE VII—WATER CONSUMPTION IN FOUR CITIES OF HOLLAND IN 1926
U. S. Gallons Per Capita Per Day

City	Year	Population	Water Consumption
Amsterdam	1926	730,000	30
's Gravenhague	1926	410,000	27
Harlem	1926	81,000	15
Rotterdam	1926	560,000	35

TABLE VIII—PER CAPITA CONSUMPTION ALLOWANCES FOR VARIOUS CLASSES OF COMMUNITIES SERVED BY APULIAN AQUEDUCT SYSTEM, SOUTHERN ITALY

U. S. Gal. Per Capita Per Day	Communities (Population)
32.8	Bari, Lecce, Foggia, Barletta, Toranto
	Gravity Supply
22.2	More than 20,000
19.2	10,000–20,000
16.9	5,000–10,000
15.6	5,000 or less
	Pumped Supply
15.6	10,000 or more
14.4	5,000–10,000
12.7	5,000 or less
Total population to be served	3,000,000

TABLE IX—DAILY PER CAPITA WATER CONSUMPTION IN METROPOLITAN WATER AND SEWERAGE DISTRICT, NEW SOUTH WALES, AUSTRALIA, 1911–26

Year	Population Supplied	U. S. Gal., for All Purposes	Year	Population Supplied	U. S. Gal., for All Purposes
1911	731,180	49.8	1919	1,060,230	54.4
1912	776,065	50.4	1920	1,109,430	52.5
1913	830,560	52.8	1921	1,146,370	53.3
1914	878,790	49.0	1922	1,197,640	56.8
1915	917,990	51.5	1923	1,254,020	56.2
1916	968,215	50.0	1924	1,298,995	53.0
1917	993,000	49.9	1925	1,342,790	60.0
1918	1,021,540	53.5	1926	1,400,785	60.3

TABLE X—DAILY PER CAPITA WATER CONSUMPTION IN 19 FRENCH CITIES

From *La Technique Sanitaire et Municipale*, June, 1928, p. 139.

City	Population	Population Served by Water	Number of U. S. Gallons Per Capita Per Day
Vienna	23,732	21,335	290
Grenoble	77,000	75,000	250
Saint-Claude	13,000	12,339	203
Dieppe	24,402	24,402	150
Paris	2,906,472		43 (industrial) 63 (potable)
Vichy	19,000 (winter)	75,000 (summer)	100 (summer) 66 (winter)
Lyon	561,592	450,000	80
Clermont-Ferrand	75,000	65,000	73
Lorient	42,000	40,000	50
Nice	173,000	173,000	50
Bordeaux	270,000		49
Rouen	125,000	125,000	41
Amiens	95,000	95,000	24 to 39
Constantine	78,200		31
Lille	225,000	225,000	25
Nantes	180,000	170,000	20
Versailles	64,758	64,758	18
Saint-Nazaire	42,000		18
Breat	73,960	73,960	13

TABLE XI—WATER CONSUMPTION IN TWENTY GERMAN CITIES IN 1921

From "Handbuch der Wasserversorgung," by Erwin Gross, 1928, p. 38. Munich: R. Oldenbourg.

City	Population	Water Consumption U. S. Gal. Per Capita Per Day	City	Population	Water Consumption U. S. Gal. Per Capita Per Day
Ülzen	12,500	7.25	Magdeburg	296,022	28.25
Eichwalde	2,705	8.50	Altona	208,000	34.25
Grimma i. Sa.	11,500	10.75	Cologne	524,550	43.00
Prenzlau	23,000	11.10	Essen-Ruhr	390,953	51.50
Naumburg	28,000	17.50	Stolberg	22,000	60.50
Falkenstein	15,000	19.00	Bochum	145,622	68.25
Osnabruck	89,619	20.25	Dortmund	490,020	69.00
Pirmasens	41,000	22.25	Biel	37,000	77.75
Wittenberg	26,000	23.00	Troisdorf	16,426	98.75
Bautzen	27,000	26.00	Stadt Bochum	196,603	105.50

are shown in Tables VII (Holland), VIII, IX, X (France) and XI (Germany). A distinction should be made, in reviewing these international figures, between reasonable legitimate uses of water and unreasonable wasteful consumptions. Charges of extravagance against individual water-supply use in the United States are usually based upon the assumption that, because American use is greater than foreign, therefore American use is wasteful. Actually the case may be that Americans can afford and demand a greater per capita use of water to provide for such sanitary facilities as are automatically accepted as necessary for American standards of living. The fact that in the United States there is one automobile for every five to ten people, as against one for every 500 to 1,000 persons abroad, is not necessarily a measure of extravagance. It may be an index of economic availability.

It is extremely difficult to make comparisons between the sanitary equipment actually in use in an average American city and that in foreign cities. Such a survey would be extremely helpful in determining the relative sanitary demands of the various countries. It is quite commonly known, however, that bathroom facilities, for example, are a usual part of an average small American home and that this is by no means the case in England, Germany, France or Holland. The quantitative differences are not available for discussion, but some observations on this particular problem are suggestive.

Recently Krul has pointed out ("Potable Water Supplies in the Netherlands, presented before the 33d Congress for Public Hygiene, Rotterdam, July 6-7, 1928) that there were approximately 9,000 baths in Amsterdam in 1926, with a total population of 722,000. For the same year, he states, there were 30,000 baths in Sheffield, England, with a population of 550,000. In the average American city of the same size the number of bathrooms would probably be two to three times that of Sheffield. We should be inclined to conclude that the requirements for water, made necessary by a wider distribution of such sanitary facilities, is not an illegit-

imate, wasteful use, but represents a legitimate necessary sanitary demand, in keeping with the standards of living currently accepted in the United States.

It is interesting to refer to Table VIII, giving the assumed per capita consumption data in the design of the Apulian aqueduct system in southern Italy a few years ago. Sanitary equipments in such areas are notoriously inadequate as compared with American standards. The figures, if adapted to conditions in the United States, would create considerable hardship and would be considered as restricted rationing of water rather than as legitimate sanitary requirement.

Some four years ago John Bowman, in a paper presented before a meeting of the Institution of Water Engineers of Great Britain, indicated that the average daily per capita consumption in 58 cities in Great Britain ranged from 17 to 84 gal. In 29 cases it was 30 gal. or under (these figures are in U. S. gallons). He stated further that in Durban, South Africa, the quantity of water used for domestic purposes averaged 30 gal. per day out of a total daily average of 72 gal. per capita. Thirty-six years ago the consumption was 16 gal. per capita per day, none of which was industrial.

Bowman presents some interesting results of tests made about 1923 in Edinburgh, Scotland. In the tenement districts, with no baths, the per capita daily consumption averaged less than 10 gal.; in self-contained houses with baths, 32 gal.

This is not the place, of course, to view in detail the progress in installation of sanitary equipment in this country, as illustrative of a possible explanation of high water use, but it is not without significance that in the United States the sale of bathtubs increased from 415,496 in 1919 to 1,101,000 in 1927, with a corresponding increase in population in the same interval of less than 15 per cent (1928 Report, U. S. Secretary of Commerce. Ref. *Public Works*, December, 1928, p. 493).

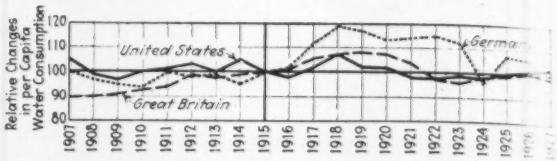
It is by no means obvious, for example, that an average daily per capita use of 400 gal. in Beverly Hills, Calif., is an illegitimate use or a perpetual orgy. Beverly Hills, a strictly residential city of about 13,000, is 100 per cent metered. Its water rates are reasonably calculated to conserve water. Yet its average daily summer demands run as high as 500 gal. per capita, with peaks of nearly double this. The explanation is clear. Large estates, private swimming pools, well-cultivated lawns and private houses with three to five bathrooms explain a phenomenal use, but shall we call it waste or legitimate consumption?

In general, these figures show that the per capita daily use in the municipalities of the United States is considerably in excess of that in foreign countries. Although some of this excess may be attributed to undue waste, to the absence of meters and to the greater availability of water-supply resources, a considerable part of the difference probably lies in a distinctly higher standard of living, or at least a higher demand for sanitary equipment, in the United States.

Conclusions

As a result of a survey of the water-supply uses of a number of cities in the united States and abroad, the following general observations appear valid:

1. There is a general tendency for per capita water-supply use to rise with industrial prosperity and to fall with industrial depression. This general trend is significant in amount, is independent of such restrictive devices as metering and high water rates and in many instances the effect of such trend is of greater magnitude than the more commonly accepted causes of variation in per capita water use.



COMPOSITE TRENDS IN DAILY PER CAPITA WATER CONSUMPTION IN THE UNITED STATES, GREAT BRITAIN AND GERMANY

Based on simple arithmetical averages of averages for each city, using 1915 figures as base of 100.

2. The effects of industrial prosperity or depression upon water use are greater in amount than are those of increasing populations alone. The latter phenomenon has been ably pointed out by Leonard Metcalf. ("Studies Upon Effect of Water Rates and Growth in Population Upon Per Capita Consumption," *Proc.* Pa.W.W.Assoc., 1925, p. 54, also *Jour.* A.W.W.A., January, 1926, p. 1.) It is believed that the effect of population increase in increasing per capita water use has been overestimated, except in so far as population increase reflects industrial expansion and prosperity. In many instances in the United States and abroad, per capita use falls or rises profoundly with no change in or with an upward trend of population. Grouping of consumption figures for five- or ten-year periods would tend to mask these real causes and effects.

3. The actual water used per person per day for domestic purposes is two to three times as great in the United States as in foreign countries. There is some evidence to indicate that this difference in use is not wholly one of waste or extravagance, but probably has its origin in the fact that the standard of living and the demand for sanitary facilities have reached a higher level in the United States than elsewhere.

4. In forecasting water-supply requirements in municipalities in the United States, serious consideration should be given to the factor of influence of standard of living and economic status upon required per capita water use.

"Plus un peuple est civilisé, plus est grande la place qu' il fait à l'eau" (*L'Eau*, May 15, 1928, p. 3, also *L'Animateur des Temps Nouveaux*, April 6, 1928).

Acknowledgments—This opportunity is taken to extend to the water-works officials in the United States and abroad my great appreciation for their co-operation in supplying me with the detailed data serving as the basis for this study. Since they number more than 50, it is impracticable to list their names here. A. W. Blohm and J. R. McComas, of my office, are responsible for the preparation of the charts and Miss E. V. Gipe, my secretary, for the tabulation of the figures. My brother, Leo Wolman, originally suggested to me the topic of this contribution for study.

Landing Fields More than Double in 20 Months

In June, 1927, the Standard Oil Company of California issued a landing-field guide for the Pacific Coast territory, listing 144 fields. New fields were built so extensively that in March, 1929, a new issue of the guide was published, this time listing 325 fields in the same territory, an increase of 125 per cent.

Detroit Water Board Builds for Itself and Other Departments

Occupies Nine Lower Floors of 20-Story Office Building and Rents Remainder to Other City Departments

By George H. Fenkell and D. C. Grobbel
General Manager and Chief Engineer, and Chief Clerk and Assistant Secretary, Respectively, Detroit Water Board

FOR several years the need of an adequate office building to house the various bureaus of the Department of Water Supply of the city of Detroit had been apparent. Studies determined that the future office space needs of the department should be based upon the estimated increase in population. Population studies showed that it was fair to assume that by 1960 the present city would have a population of approximately 3,400,000 (based on the 1926 population). Likewise a survey of the department's activities disclosed the amount of space needed for efficient operation. The floor area thus arrived at was based upon the present operations of the department, and did not take into consideration any new ventures, such as the administration and operation of a Metropolitan Water District, the annexation of additional territory to the city, and such matters as the operation and maintenance of sewage-works, the tax for which under Michigan laws is levied upon the amount of water used on a premises. Presenting these studies to the appropriating body of the city, the Board of Water Commissioners obtained the needed appropriation to construct an office building.

For a site the city sold to the Board of Water Commissioners at $250,000 a triangular piece of land between Farmer, Randolph and Bates Sts., formerly occupied by the Police Headquarters Building, two blocks from the City Hall, easily accessible to transportation lines, and in a district much neglected by business. The land sold to the board has a frontage on Randolph St. of 168.67 ft., on Farmer St. 161.19 ft., and 174.6 ft. on Bates St. Louis Kamper, Inc., architects, designed a building with basement, 20 stories of office space and 3 stories of pent house. The City Plan Commission required that in view of the probability of widening Randolph St. the building must be set back 26 ft. from the present street line, and its dimensions therefore become 152 ft. on Bates St., 147 ft. on Randolph St., and 140 ft. on Farmer St., with a total floor area of 113,336 sq.ft. of useful office space, exclusive of lobbies, elevators and other interior structures. Above the fifth story there is a setback, reducing the useful space per floor to 5,630 sq.ft., compared with 6,200 sq.ft. on the lower floors.

The building has skeleton steel frame with walls of Indiana limestone backed with hollow tile. It rests on caissons carried to an average depth of 120 ft. The floors are concrete flat slabs on steel beams and girders. There are six high-speed elevators, and a hydraulic freight elevator from the first floor to the basement. The stairways are of steel with cement treads and landings. The trim throughout is Tennessee marble. The building is heated with steam supplied by the Central Heating Company. The basement provides space for machinery and for a garage that will accommodate thirty cars.

The contractor began to remove the old building on Feb. 9, 1928, and the entire department was in the building by Oct. 1.

OFFICE BUILDING OF DETROIT WATER BOARD
First nine stories reserved for board; remainder rented to city departments. Parking space in basement. Deep setback provided against future widening of Randolph St.

The Department of Water Supply at the present time is to occupy nine floors of the building. The administrative offices of the board room are located on the fifth floor; the first four floors are occupied by the offices having relations with the general public and the sixth, seventh and eighth floors by the present engineering forces. The ninth floor is used for a women's rest room, medical department and a general assembly hall. This floor is in charge of a trained nurse and the rest room is to be used by all the girls in the building, the Water Department itself employing approximately one hundred. The medical department will be fitted for examinations and for the treatment of minor ailments and accidents. The remaining floors are to be rented to other city departments which were renting space in privately owned buildings, and some departments from the City Hall, which building has inadequate accommodations for all city departments, have already moved into the building.

The cost of the building and fixed equipment totaled $1,454,432, which is at the rate of 61c. per cubic foot. Through the co-operation of all the contractors, the building was completed and ready for occupancy seven months after breaking ground.

Architecturally the building is designed for use rather than for monumental effect; but in the cashier's lobby on the main floor, where the public throngs to pay water bills, and in the water board room on the fifth floor, where public hearings are given, decorative art is given a prominent place in the form of mural paintings on the ceilings. Those on the first floor relate in part to the history of Detroit, as associated with water, and in part allegorical figures representing attributes of water. Those on the fifth floor relate to both the city and the state, also partaking of both the historic and the allegoric.

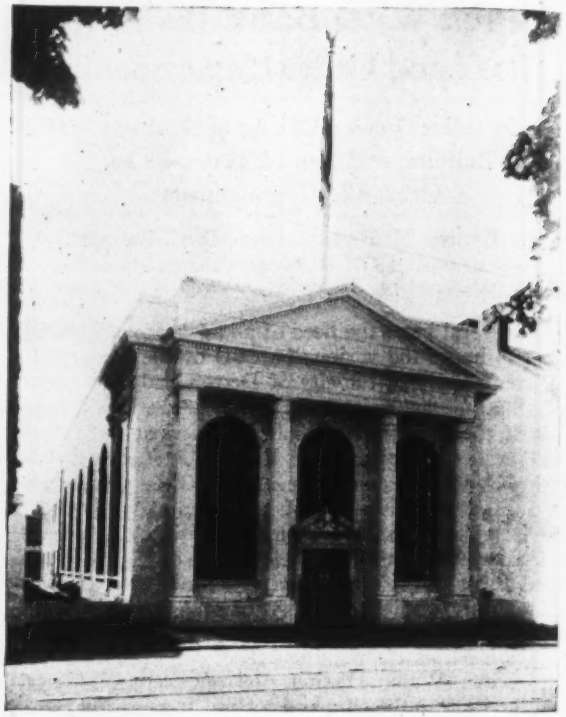
Administration Building of York Water Company

Two Floors and Basement Devoted to Office Force With Light and Air on All Sides—Meter and Service House Near

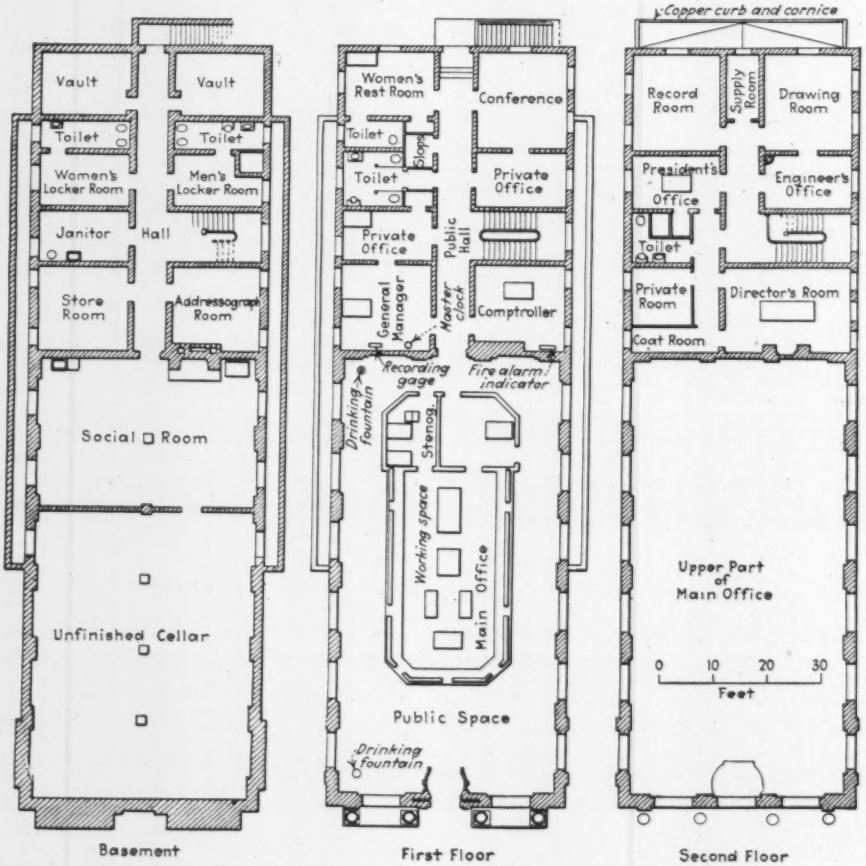
By Edgar P. Kable
General Manager, York Water Company, York, Pa.

THE York Water Company, owner and operator of the water-works which supplies the city of York, Pa., and vicinity with water, has just built a complete up-to-date and handsome administration building. The exterior is of white Georgia marble, with four free-standing monolithic columns and a full pediment dominating the façade and lending themselves admirably to a modern adaptation of the Georgian period of colonial architecture. Located as it is in the center of a 65-ft. lot on the Lincoln Highway in the business center of York and flanked on either side with a graceful wrought-iron fence terminating against marble posts, the setting will permit of side planting and general beautification.

The building is about 40x140 ft. in plan. At the front of the first floor there is a public space of 3,200 sq.ft. floored with marble tile and terminating with a marble counter. The counters are of the "friendly" type, without any grill or glass, permitting the clerks and consumers to see each other face to face. Walls of scagliola and a 25-ft. ceiling richly ornamented combine to make the public space unusually attractive and inviting. Thirteen large semicircular windows of bronze go to a height of 22 ft. above the floor level, ending in groined arches as they meet the ceiling cove. The rear of the public space is devoted to offices for the general manager and the comptroller, with a large room for general conferences, a rest room and toilet facilities for woman patrons. On the mezzanine floor are the directors' room, the president's office, engineers' and draftsmen's quarters and storage space for records and plans. The modern mechanical equipment—plumbing, heating, lighting, power and telephone systems—makes for staff efficiency and facilitates business with the consumer. The meter and service departments are housed within a few feet of the rear of the office building, thus affording easy access from one to the other. The plans for the new building were drawn by Edward Leger and William B. Billmeyer, registered architects, of York, who associated themselves in the design.



FRONT VIEW OF OFFICE BUILDING OF YORK WATER COMPANY



OFFICE FLOORS OF YORK WATER COMPANY

Small-Bore Tunnel Driving in New England

Comparison of Methods of Drilling, Mucking and Lining Municipal Water-Supply Tunnels at New Haven, Waterbury and Springfield

AQUEDUCT TUNNELS exceed in mileage all other kinds in the United States. The greater number is for water supply, but water-power development also calls for many. In general the tunnel aqueducts of both classes are of small diameter—rarely more than 10 ft.—and they therefore present distinctive construction problems arising from limited working space. In plan of attack, in blasting and mucking, in haulage and services for ventilation, drainage and power supply and in lining methods the constructor has to work out special adaptations of large tunneling equipment and practices. This is a task that often calls for much experimentation the results of which can be learned only by a survey of operations in progress. In this article are given the results of such a survey of three water-supply tunnel aqueduct operations in New England. Other surveys in progress and completed of single operations or groups of operations will follow as the data are developed. They will present the factual story of current practice in small bore tunneling. —EDITOR.

EXTENSIONS of the water-supply systems for New Haven and Waterbury, Conn., and for Springfield, Mass., call for six aqueduct tunnels. All of these tunnels are under construction or have been only recently completed, some by day labor and others by contract construction. The account of the operations which follows is a factual survey solely. A description of the tunnels and tunneling conditions is followed by a statement of the drilling, mucking and lining methods employed.

Description of the Projects

The comprehensive project for the extended water-supply system for New Haven, Conn., was outlined in *Engineering News-Record*, Sept. 12, 1928, p. 391. A similar project description of the new Springfield, Mass., operations was published in *Engineering News-Record*, July 26, 1928, p. 124. The Waterbury operation is outlined in the map and description which follow:

Waterbury Project—In Waterbury's new Shepaug Valley water development (Fig. 1) a 5-mile section of the Shepaug tunnel with two 45 deg. changes of alignment and passing 150 ft. under Bantam Lake was driven without shafts or adits. The tunnel, 7¼ miles long, taps a 37-square mile watershed on the Shepaug River, carrying the water to the present supply system in West Naugatuck Valley. It has 3-ft. vertical sidewalls and a semicircular arch of 3-ft. radius. Except for three short sections, the tunnel is in rock, with mica schist predominating.

At the Bantam River, 2½ miles east of the Shepaug, the tunnel strikes the surface for a gap of 700 ft. This gap is crossed with a pressure siphon of four 36-in. cast-iron pipes buried in concrete. For 300 ft. at the Shepaug portal, glacial drift and hardpan were encountered before solid rock was entered.

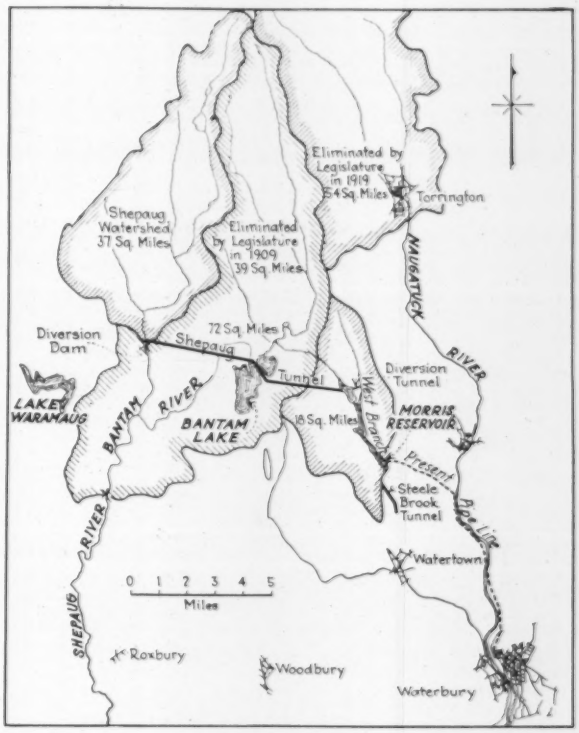


FIG. 1—MAP OF SHEPAUG TUNNEL DEVELOPMENT, WATERBURY, CONN.

This stretch required practically the only timbering in the entire tunnel. A difficult stretch of 570 ft. was traversed at the Ravenscroft swamp 2½ miles east of the Shepaug portal, where the rock dips below the tunnel grade. Here an open trench 30 ft. deep lined with steel sheeting was dug through the overlying material, consisting mostly of peat bog and silt, nearly fluid when saturated. A concrete tunnel section resting on wood piling driven to rock was built in the trench.

Future plans call for storage reservoirs at each end of the tunnel, but at present a concrete diversion dam across the Shepaug River and the existing Morris

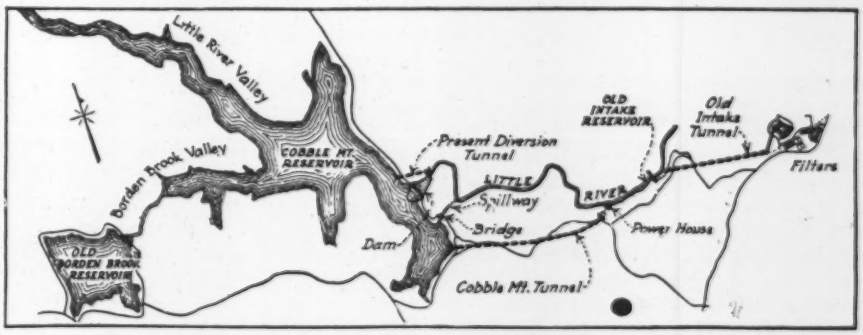


FIG. 2—MAP OF COBBLE MOUNTAIN DEVELOPMENT, SPRINGFIELD, MASS.

reservoir in the west Naugatuck Valley will suffice. Another tunnel, known as the Steele Brook, is being driven as part of a new pipe line from the Morris reservoir to the city. A trifle more than a mile in length, it is being worked from the upper heading only. Four headings were used in the Shepaug tunnel, one from each portal and two from the Bantam River crossing.

Springfield Project—A 12½-ft., horseshoe-section diversion tunnel 1,600 ft. long was driven to carry Little River around the Cobble Mountain dam site at Springfield, Mass. Little River is at present a source of water supply for the city, hence unusual precautions had to be taken during construction to avoid pollution. The tunnel is serving as a diversion for the river during the construction of the dam and will later be one of the two controlled outlets from the reservoir (Fig. 2). To provide for the future controlling works, a 10x10-ft. shaft, 210 ft. deep, was both raised and sunk 350 ft. from the upper portal. The tunnel was driven almost entirely from the upper portal, and the shaft sinking was carried on independently of tunnel operations. A 9-ft. pressure tunnel 8,000 ft. long is now being driven at Cobble Mountain, but is not considered in this article.

New Haven Project—Three 6-ft. 8-in., horseshoe-section tunnels are a part of the North Branford development of the New Haven water-supply system. The project consists of the newly formed 15,800-m.g. Totoket storage reservoir, which will receive the runoff of three watersheds, two supply tunnels and one outlet tunnel (Fig. 3). The outlet known as the Great Hill tunnel is 2,800 ft. long, lies in standstone and trap rock and is concrete lined throughout. It was driven from a heading at each portal. The two intakes, known as the Gulph and Sugar Loaf tunnels, are 4,700 ft. and 13,800 ft. long, respectively. These are both concrete lined except through a stretch of trap rock in the Gulph tunnel. On the Sugar Loaf bore driving progressed from four headings, one at each portal and two from a 100-ft. shaft. One portal heading only was used on the Gulph tunnel. Provision is made for extending the Sugar Loaf tunnel 5 miles eastward to the Hammonasset River for future additional supply.

Drilling and Blasting Methods

Drilling and shooting diagrams of all the tunnels are shown in Fig. 4. Drifter drills mounted on columns and drilling holes about 12 ft. deep were used on all of the headings except at the Shepaug tunnel, where jackhammers mounted on columns were used at the start, but these were soon replaced with the heavier drills. At the Shepaug tunnel the drill steel used was 1⅛-in. hollow round, an unusual size but most economical, according to the engineers. Using 2-ft. changes, the gage started at 2 in., reducing ⅛ in. for each change. The records show 1¾ lb. of steel used at a cost of $0.27 per foot of tunnel. At all the other tunnels 1¼-in. steel was used. Drilling methods varied somewhat according to the nature of rock encountered and according to the judgment of the heading foreman, but for the most part conformed closely to the diagrams as shown in Fig. 4.

In the New Haven tunnel different methods were used for the sandstone and the trap rock headings. In sandstone eight cut holes were loaded and shot first, which usually only partly pulled the cut. Then what was left of the cut holes was again loaded along with the relievers, breakdown and rim holes. The cut holes on the second loading were shot direct, the two side relievers and two breakdown holes on the first delay, six side rim holes on the second delay and three top rim holes and two bottom corner relievers on the third delay. About 280 sticks of dynamite were used in each series of shots. On the Gulph tunnel in the trap rock section the procedure varied somewhat. The eight cut holes were drilled higher than in the sandstone section, with two relievers used on each side and one reliever above the cut replacing the two breakdown holes. Besides the two lower corner relievers an extra bottom reliever was used. Two center busters were used in addition to the cut holes. In shooting, the eight cut holes and two busters were loaded and shot separately, partly pulling the cut. The cut holes and busters were again loaded and shot direct, the five relievers shot on the first delay, the six side rim holes on the second delay the three top holes and the three bottom relievers on the third delay. These methods as described were typical, but varied at times according to the material.

At the Shepaug tunnel a 24-hole shot on a full face heading was used most of the time. Eight cut holes and two center busters were loaded and shot first. The remaining holes were then loaded and shot in delays. The four relievers were fired first, then the rim holes and lastly the four lifters which threw the muck back from the face.

At Cobble Mountain the heading and bench system was used at first. For 392 ft. the contractor experimented with various lengths of bench, various numbers of shots and different positions and angles of cuts, as well as variable loadings. A full face heading was then tried, drilling 43 holes about 12 ft. deep. The various heading and bench methods used, as shown in Fig. 4, were experiments to determine the best method of drilling and shooting for the kind of rock encountered. Headings and benches were usually, though not always, shot independently. However, the full face method proved to be the best and was used for the remaining 1,200 ft. of driving. The full face heading used ten cut holes and two busters, which were loaded and fired separately. Then what remained of these holes after the first shooting was again loaded and fired with the remaining holes in the following order: direct, eight cuts, two busters, four relievers, two lifters and two breakdown holes; first delay, eight side rim and five breakdown holes; second delay, the remaining ten top rim holes. The cut holes were loaded with fifteen sticks and the remaining holes with ten sticks of 60 per cent gelatin dynamite. The heading advanced about 10½ ft. per round.

On all of the tunnels jackhammer men followed up the drilling crews, trimming tight spots and drilling the necessary dowel holes to accommodate hangers for invert forms, waterpipes, air lines and power lines. For a

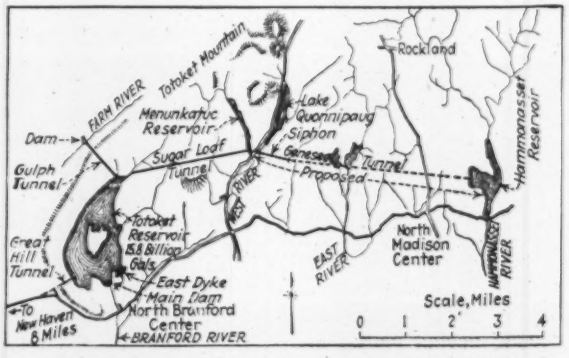


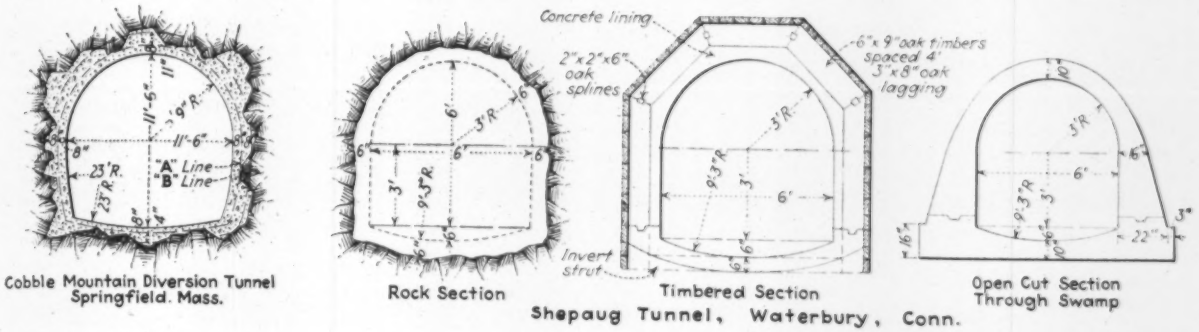
FIG. 3—MAP OF NORTH BRANFORD DEVELOPMENT, NEW HAVEN WATER COMPANY

distance of 54 ft., at the lower end of the Cobble Mountain tunnel, jackhammer drills were used on a full face heading, drilling and shooting at random.

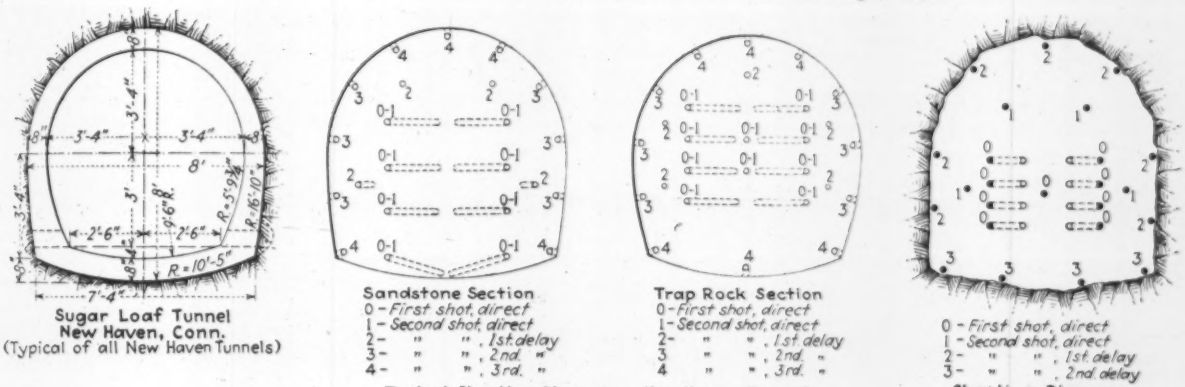
Mucking and Disposal Methods

The Shepaug tunnel was mucked entirely by hand. In the New Haven tunnel electrically operated mucking machines were used for the most part, although at two headings the muck was loaded by hand onto a belt conveyor, which discharged directly into the car. This had the advantage of eliminating the high lift by hand over the sides of the cars. At Cobble Mountain an air-operated mucking machine was used. At New Haven the working cycle per shift was approximately as follows: At 7 a.m. the mucking crew started to work on the material blasted by the night crew going off shift. By 11:30 a.m. the mucking had progressed far enough to permit the drill crew to start work. Usually by 4:30 p.m. the headings were drilled and by an hour later were loaded ready for shooting. After the mucking crews had finished they extended the tracks, pipe lines and ventilating tubes. The shooting was done just as the crews were going off shift.

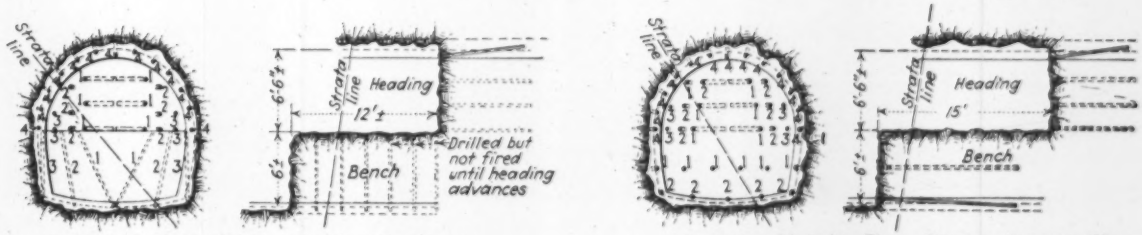
In the Shepaug tunnel the procedure varied a little.



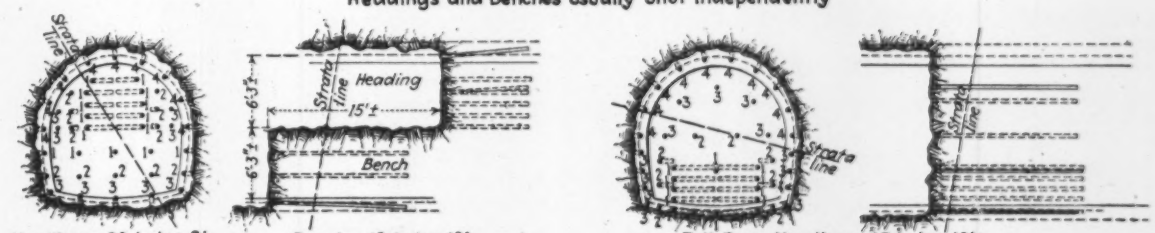
Shepaug Tunnel, Waterbury, Conn.


Sugar Loaf Tunnel New Haven, Conn. (Typical of all New Haven Tunnels)
Sandstone Section
0 - First shot, direct
1 - Second shot, direct
2 - " " , 1st. delay
3 - " " , 2nd. "
4 - " " , 3rd. "
Trap Rock Section
0 - First shot, direct
1 - Second shot, direct
2 - " " , 1st. delay
3 - " " , 2nd. "
4 - " " , 3rd. "
0 - First shot, direct
1 - Second shot, direct
2 - " " , 1st. delay
3 - " " , 2nd. delay
Shooting Diagram Shepaug Tunnel

Typical Shooting Diagrams, New Haven Tunnels



Headings and Benches Usually Shot Independently



Typical Shooting Sections, Cobble Mountain Diversion Tunnel

Heading and Bench Methods Tried for Short Sections before Full Face Method was Finally Adopted

FIG. 4—TYPICAL SECTIONS AND SHOOTING DIAGRAMS, NEW ENGLAND WATER TUNNELS

After the blast a dog shift of three men cleared the muck away from the face and scaled all loose material from the sides and arch. A mucking crew of eight men and a foreman then loaded out by hand. Mucking machines and belt loaders were in turn discarded as being too cumbersome for the small bore. The drilling crew started after the mucking crew, usually within two hours. After clearing up the muck, this crew lengthened out the air, water and ventilating pipes and extended the track. Laying the muck dam was the last operation of this crew before going off the shift. By the time the mucking crew had everything cleaned up the drill crew had finished the drilling and loading, and the heading was shot as the crew was going off shift. Day and night shifts were used, with about an hour between shifts to allow the tunnel to ventilate after the blast.

As in all small tunnel work, the switching of muck cars was a serious problem. At Cobble Mountain the diameter was large enough to permit permanent sidings to be placed about every 400 ft. On the smaller tunnels there was not room for sidings, so different methods had to be used. At the Shepaug tunnel no attempt was made at switching. Instead, unusually light wooden cars were built on the job. These cars (20 cu.ft.) were light enough to be lifted off the track by two men. A string of empties was shoved against the heading and the cars were thrown off the track on their sides. One at a time they were replaced, loaded and shoved back into the clear. In spite of rough handling these cars stood up remarkably well. The excavated material was hauled out in ten-car trains by storage battery locomotives and handled at the portals by gasoline dinkies.

On the New Haven tunnel another method was used for switching. About every 250 ft. one side of the tunnel was widened enough to permit a spur track to be built just long enough to accommodate one or two cars. Side dump cars of ¾-cu.yd. capacity, as shown in Fig. 7, were used. The loading cycle was to push a string of eight empty cars against the heading by an electric storage battery locomotive. As the car next to the heading was loaded the whole string was brought back and the loaded car shoved into the nearest spur track. The string of empties was again shoved against the heading and while the next car was being loaded the locomotive went back and picked up the loaded car and placed it at the rear end of the empty train. This procedure was repeated until all of the cars were loaded. They were then hauled to the portal or to the shaft, depending on the heading being worked. At the Sugar Loaf shaft the cars were hoisted to the surface by an elevator and run out to the dump by a Ford-powered locomotive. At the east portal of Sugar Loaf, which ended in a deep cut, the cars were hoisted to the dump by a stiff-leg derrick. At the west end of Sugar Loaf tunnel the cars were hauled to the dump by a cable and steam hoisting engine. At all the other portals the cars were handled by gasoline dinkies.

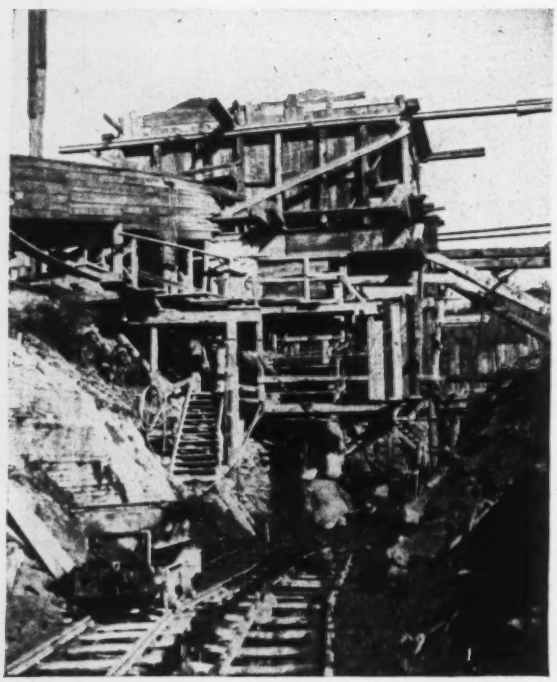


FIG. 5—CONCRETE PLANT, WEST PORTAL, SUGAR LOAF TUNNEL
Note type of car in foreground used for pneumatic placing machines in small-bore tunnel lining.

FIG. 6—FALSEWORK SUPPORTING SIDEWALL FORMS FOR INVERTS, COBBLE MOUNTAIN DIVERSION TUNNEL

Drainage and Ventilation—Some of the headings were drained by gravity, while others required constant pumping. At the Shepaug tunnel small air-operated duplex piston-type pumps were kept as close as possible to the heading, being moved forward with every 300 ft. of tunnel progress. These small pumps picked up all drainage water at the face from manholes and forced it back to permanent electrically driven centrifugal pumps which were placed about every 4,000 ft. in manholes, draining the entire tunnel length. A drainage pipe was laid in a bottom corner, all the other parts and wires being hung high on the arches.

On the New Haven tunnel centrifugal pumps were installed at the base of the Sugar Loaf shaft. At all the other headings which required pumping, air-operated piston pumps were used to pump to the portal without any intermediate collecting pump. Air-operated piston pumps were also used at Cobble Mountain to keep the heading dry.

Because of the early completion of the control shaft at Cobble Mountain no artificial ventilation was used on this tunnel. At New Haven forced ventilation was

supplied to each heading by reversible fans. Fresh air could be forced into the headings or the foul air drawn out by these fans through 12-in. spiral riveted pipes.

Concrete Lining

The concrete lining for arch and sidewalls of all tunnels was placed by pneumatic concrete-placing machines. On all three projects the invert and haunches were poured before starting the sidewall and arch lining.

Unusually fast progress was made on the New Haven tunnel lining, averaging 370 ft. per day on the invert and haunches and 100 ft. per day on the sidewall and arches. A 1 : 2 : 3½ mix was used in both the invert and arch sections of these tunnels, 6 per cent hydrated lime being added to prevent segregation during transit. The forms for the haunches consisted of 6-in. steel channel sections hung by adjustable hangars 10 ft. apart which were fastened to drill steel doweled into the tunnel wall. This channel formed the inside of the vertical haunch section and also provided a templet for the invert screed. The track was carried on short horses over the invert sections being concreted, the horses being removed before the concrete had set.

The entire apparatus for concreting the sidewall and arch was carried on a 24-in. gage track laid on the invert

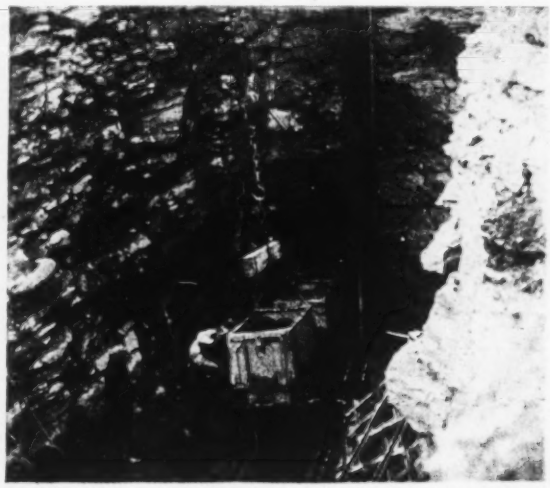


FIG. 7—LIFTING MUCK CARS OUT OF EAST PORTAL CUT, SUGAR LOAF TUNNEL

concrete. This apparatus consisted of five 20-ft. collapsible steel form sections, the pneumatic placing machine and a ramp track leading up to the level of the machine, with a track extension long enough to accommodate an eight car train. A tugger air hoist pulled the cars up the ramp onto the carriage. On account of the narrow clearances within the tunnel, special roll-over cars were designed, each with a capacity of ⅔ cu.yd A portable section of passing track permitted the operation of more than one train of the narrow concrete cars within the tunnel.

The pouring cycle was as follows: concreting, six to eight hours; setting, eight hours, and stripping, moving and resetting forms, five to six hours. No provision was made for grouting on the New Haven tunnels, except the Great Hill Tunnel.

The invert and haunch sections of the Shepaug tunnel were concreted as at New Haven. The haunch sidewalls for a height of 8 in. were poured with the invert. The side forms necessary for this were light steel angle and plate sections, built up on the job and constructed with slip end joints. The sections were hung from the tunnel walls by adjustable eyebolts. The spreaders consisted of steel bars shaped to act as invert templets which slipped over the side forms without bolting. The invert concrete was poured from end dump cars (Fig. 8), the tracks at the point of pouring being temporarily supported by horses.

The invert concreting was completed before any full-section lining was attempted. Collapsible steel forms

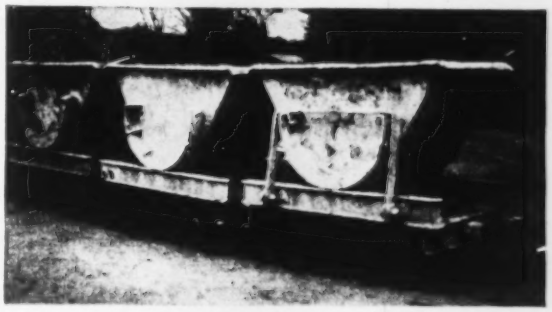


FIG. 8—TYPE OF 2-FT. GAGE ROLL-END CARS USED IN POURING INVERT, SHEPAUG TUNNEL

60 ft. long mounted on wide-gage tracks were used for the full sections. Concrete for these sections was blown into place by a pneumatic machine using a rigid pipe at the top center. This pipe, in 5-ft. sections, was dismantled as the concrete advanced toward the machine. Long side dump cars (Fig. 9) brought the concrete to the machine. To insure a smooth surface, the steel forms were pounded with a jackhammer as the concrete was being placed.

Allowing eight hours for pouring, eight hours for setting and eight hours for moving and resetting the forms, 60 lin.ft. of lining per day was completed.

Provision for grouting pockets and seams was made before pouring the lining. Special form plates with threaded holes were used wherever a grout hole was necessary; a pipe length was inserted into the seam or pocket, and the other end was screwed to a plug in the hole in the special plate. The pipe was concreted in place; screwing out the plug released the form from the pipe. The pockets were later grouted to refusal by pneumatic grouting machines.

In the open section through Ravenscroft Swamp the invert and 8 in. of the sidewalls were poured in 15-ft. sections. Pouring the sidewalls and arches in 30-ft. sections followed, using collapsible steel forms. To prevent segregation of concrete in the long hauls at the Shepaug tunnel, an admixture of diatomaceous earth was used.

At the Cobble Mountain tunnel the invert and short side sections were poured first, using wood forms suspended from overhead wooden strips, as shown in Fig 6. As in the smaller tunnels, collapsible steel forms were used on the side and crown sections and the concrete was placed with pneumatic machines. The discharge pipe on this job was provided with a movable spout at the point of placing to help in getting the concrete down the sides. A man in each side wall form did what spading he could under the crowded conditions, and the forms were pounded with a jackhammer to help secure a smooth surface. There was no regular concreting schedule on this job. The points that required grouting were noted

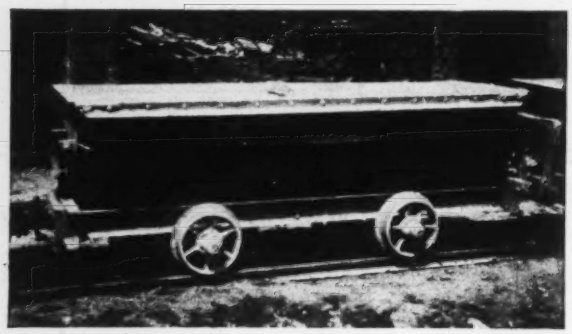


FIG. 9—TYPE OF SIDE ROLL CARS USED WITH PNEUMATIC PLACING MACHINES, SHEPAUG TUNNEL

and after the lining was placed grout holes were drilled through the concrete and the voids grouted with a pneumatic machine.

Plant Layouts

The concrete plant at Cobble Mountain was placed at the upper end of the control shaft, and the concrete was spouted down to a hopper at the bottom of the shaft. On all the remaining tunnels concrete plants were constructed over each portal. These were practically all of the same design except that at the north end of the Shepaug tunnel the plant was charged by hand, while at the rest of the plants the aggregates were handled by derricks or dumped directly to the mixer bins from trucks. The New Haven and Cobble Mountain tunnels used electrically driven compressor plants, taking the power from commercial power lines. Steam-driven compressor plants were used on the Shepaug tunnel. The Bantam River main plant at the Shepaug tunnel consisted of two steam-driven compressors of 900-cu.ft. capacity; three 100-hp. boilers; one 50-kw., 220-volt, direct-current generator; a small motor-driven generator for storage-battery charging, and boiler feed and supply pumps. The large generator supplied the tunnel lining system and current for the feeder on the concrete air blower. The plant also contained a fully equipped blacksmith shop, a small machine shop, pneumatic drill sharpeners and furnaces. A similar plant was used at the Shepaug River portal of this tunnel, and was moved later to the north portal.

Organization

The three tunnel projects varied widely in types of organizations handling the work. The New Haven project is being carried out by the New Haven Water Company, of which E. E. Minor is general manager. A. B. Hill, of New Haven, is consulting engineer on this project, with C. M. Blair as resident engineer in charge. C. W. Blakeslee & Sons, of New Haven, are the contractors on the entire work, with William H. Ryan as general superintendent and S. P. Sears engineer, for the contractors.

Day labor under the direct supervision of the city engineer was used on the Shepaug work at Waterbury. The same system is also being used in driving the Steele Brook tunnel at Waterbury. R. A. Cairns, city engineer, is direct supervisor of the project, with Herbert Scott-Smith resident engineer in immediate charge.

The Cobble Mountain project at Springfield is being built by the Board of Water Commissioners of Springfield. E. E. Lochridge is chief engineer, with H. H. Hatch resident engineer in direct charge on the work for the city. Coleman Brothers, Inc., of Boston, was the contractor on the diversion tunnel.

Centrifugal and Deep-Well Pumps Draw From One Well

Plant Has Two Types of Pumps Operating Separately or Together—Suction Pipes Are Concentric

By Earl E. Norman

Superintendent, Department of Public Utilities, Kalamazoo, Mich.

WHEN a new well was developed at the Born Court pumping station, Kalamazoo, Mich., it was found that the well could furnish water at the rate of 3 m.g.d. within the limits of suction lift, permitting the use of an ordinary horizontal centrifugal pump of that rating. It was also found that the pump could supply 7.2 m.g.d. by drawing down the water in the well to 50 ft. below the surface, which would require the use of a deep-well pump. It was expected that 3 m.g.d. would be sufficient for ordinary requirements but that at times the higher rate would be desirable.

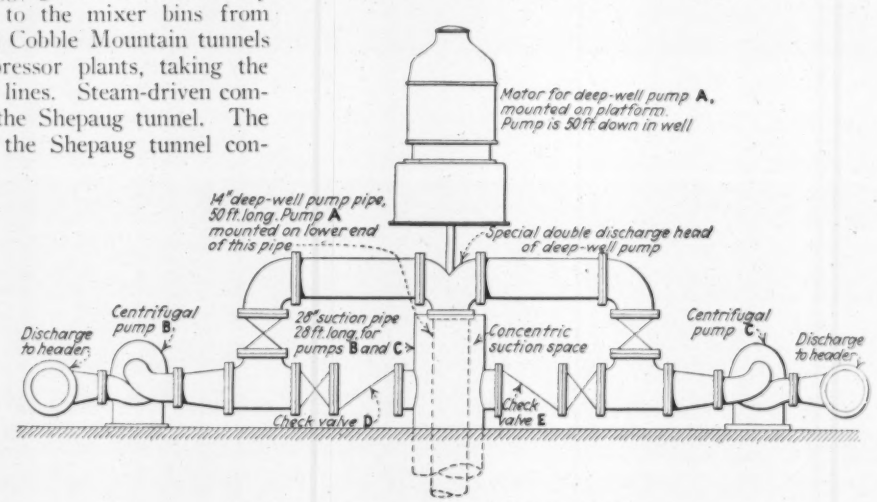

Motor for deep-well pump A, mounted on platform. Pump is 50 ft down in well
14" deep-well pump pipe, 50 ft. long. Pump A mounted on lower end of this pipe
Special double discharge head of deep-well pump
Centrifugal pump B
28" suction pipe 28 ft. long, for pumps B and C
Concentric suction space
Centrifugal pump C
Discharge to header
Discharge to header
Check valve D
Check valve E

FIG. 1—COMBINATION PUMPING PLANT

The problem was to design the station to meet both conditions. Several possible combinations of pumps and other apparatus were considered and rejected. The simplest arrangement would be a deep-well pump rated at 7.2 m.g.d. for a head sufficient to pump directly into the mains, and a horizontal pump rated at 3 m.g.d. for the same head. Two such pumps would require motors of 400 and 125 hp., respectively, or a total of 525 hp. This arrangement, however, would not give flexibility of operation and the initial cost would be rather high. The problem of using the same well with both a deep-well pump and a horizontal suction pump seemed baffling. There was not room in the well to place the drop pipe of the former and a suction pipe of proper size for the

latter pump side by side. This difficulty was solved by placing the drop pipe inside of the suction pipe, using the annular space between the two as the suction connection.

The pump arrangement finally decided upon is shown in Fig. 1. The deep-well pump, *A*, of 7.2-m.g.d. capacity (5,000 g.p.m.) was mounted 50 ft. down in the well on a 14-in. drop pipe and was provided with a special double discharge head. Two duplicate horizontal, centrifugal pumps, *B* and *C*, were provided, connected as shown. Each of these latter pumps is rated at 3 m.g.d. (2,100 g.p.m.). Either one can be operated alone, drawing water from the well through the annular suction space and check valve and discharging into the pressure header. Thus one pump can be operated while the other is under inspection or repair. If the high rate of supply is required, the deep-well pump is started, after which the second horizontal pump is started. It will be seen from Fig. 1 that the deep-well pump discharges into the suction header of the horizontal pumps, which then deliver the water into the pressure header. Fig. 2 shows a detail of the piping at the top of the well.

The horizontal pumps and the deep-well pump were designed with such relative characteristics that when all three are running there will be a pressure slightly above atmosphere (about 5 lb. gage) in the suction header, thus insuring the closing of the check valves *D* and *E*. This is quite necessary, because when the well is operated at the high rate the water draws down in it about 50 ft., which causes the water column in the annular suction space to break and drop, leaving air only in this space. The arrangement described has proved highly satisfactory.

Each pump has a 125-hp. motor, making a total of 375 hp., or 150 hp. less than would have been required for the other arrangement noted above.

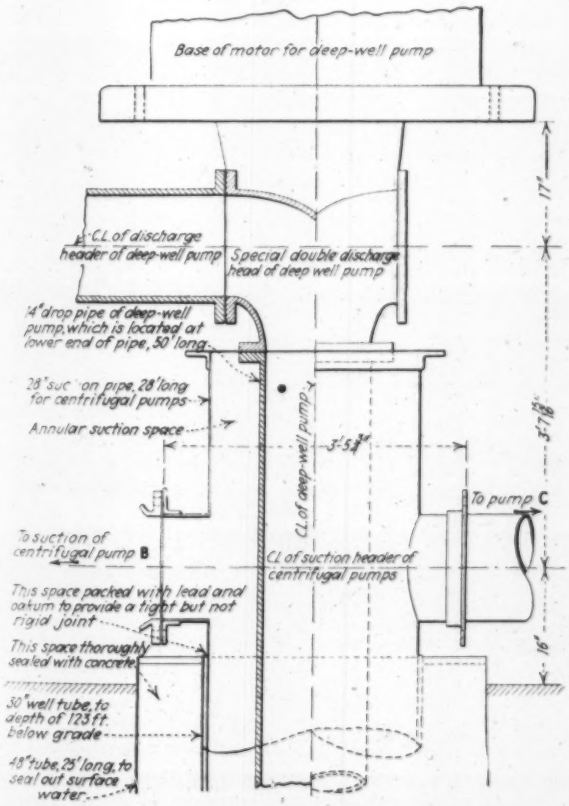

Base of motor for deep-well pump
17'
CL of discharge header of deep-well pump
Special double discharge head of deep well pump
14" drop pipe of deep-well pump, which is located at lower end of pipe, 50' long
28" suction pipe, 28' long for centrifugal pumps
Annular suction space
3'-5½"
3'-7½"
CL of deep-well pump
To pump C
To suction of centrifugal pump B
CL of suction header of centrifugal pumps
This space packed with lead and oakum to provide a tight but not rigid joint
This space thoroughly sealed with concrete
16'
30" well tube, to depth of 123 ft. below grade
48" tube, 25' long, to seal out surface water

FIG. 2—PIPE CONNECTIONS AT WELL HEAD

This pumping station is not provided with an operator, it being remotely controlled by push buttons at the switchboard in the main pumping station, several hundred feet distant. There are only two push buttons, for pumps *B* and *C*. If it is desired to operate all three pumps and pump *B* is operating, button *C* is turned "on," whereupon the deep-well pump *A* will immediately start. In about twenty seconds, while the deep-well pump has come up to speed and created a positive pressure in the suction header, the third pump, *C*, will start automatically and in a few seconds the full rating of the well and station will be delivered.

Upon turning off button *C*, pump *C* will immediately stop; but the deep-well pump, *A*, and pump *B* will continue to operate. This combination will deliver about 4 m.g.d. Upon turning off button *B*, pump *B* will immediately stop, followed by the deep-well pump about ten seconds later. This last delay creates a somewhat higher pressure in the suction header to assist in blowing out the air which has accumulated in the suction connection during deep-well operation. Pumps *B* and *C* are equipped with automatic air valves to discharge this air. The well produces a static artesian pressure of about 4 ft. above the horizontal pumps. In about fifteen minutes this pressure will discharge the accumulated air through the automatic air valves.

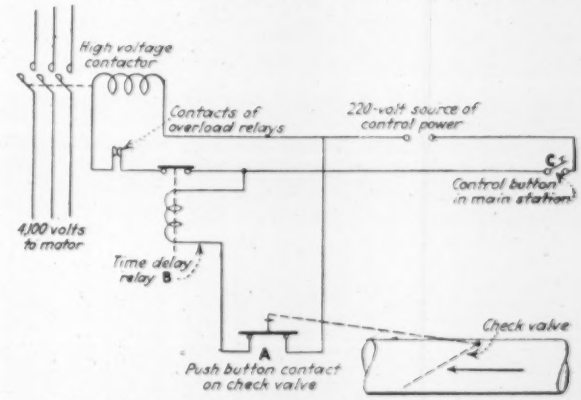


FIG. 3—CONTROL SYSTEM STOPS PUMPS FROM RUNNING WHEN DRY

A phase of the control which might prove of value to operators of centrifugal pumps is that of preventing the operation of the pumps when not primed. There is much more hazard in the operation of centrifugal pumps on account of the pumps running while dry than there is by overloading the motors; yet protection is generally provided to prevent overload on the motors, but very rarely to prevent pumps running dry.

To provide this protection, each horizontal pump is equipped on the discharge side with a check valve, which opens when the pump is discharging water and closes otherwise. The check valve has attached to the valve flapper a shaft extending through a stuffing box. On the shaft is an arm arranged to depress a push button when the valve is closed. In Fig. 3 is a diagram of this control. The push button *A* is closed when no water flows through the check valve. When relay *B* is energized, the contacts open after a delay of about 45 seconds, but close immediately it is de-energized.

When button *C* on the main switchboard is closed, the main contactor operates, throwing the pump motor on the line. Relay *B* is energized at the same time and its plunger starts to open its contacts. If the water starts flowing through the check valve before 45 seconds has

elapsed, button *A* will open the circuit through the relay and the pump motor will continue to operate. If for any reason the pump does not discharge water for a period of 45 seconds or more, relay *B* will open its contacts, thus opening the main contactor circuit and shutting down the pump motor. The relay will remain in this position as long as button *C* remains closed.

The operator at the main switchboard can observe the current taken by the pump motors and can observe the flow of water by means of a remote recording electrically operated flow meter. When he observes that the pump has dropped out, he throws *C* to the "off" position, which immediately resets relay *B*. He can then try starting the pump again, but this will be successful only if the pump starts delivering water within 45 seconds after the motor starts. This feature of the control has proved valuable and several times has prevented a pump running dry, with the consequent damage to rings and other parts.

The pumping arrangement and control were designed by the writer. The well was put down by the Layne-Bowler Company, Memphis, Tenn. The pumping station was built by the city's construction gangs at a total cost of $38,206, including building, land, well and equipment.

Remodeling Pumping Station of Willimantic Water-Works

Adding New and Changing Old Water-Power Pump and Improving Race Increase Efficiency and Cut Out Steam Power

By Henry W. Taylor
Consulting Engineer, New York City

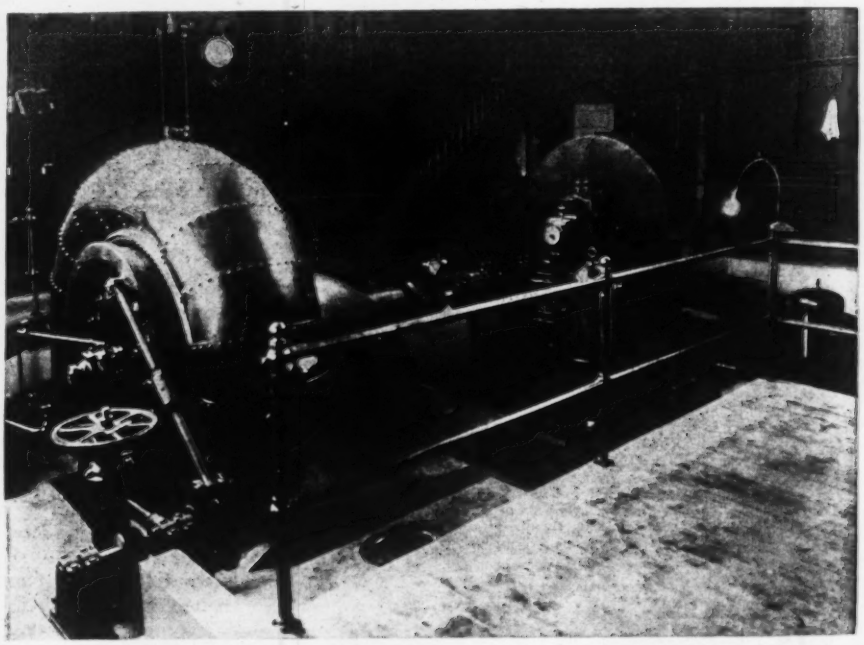
During the last two years a new pumping unit, installed for the water-works of Willimantic, Conn., has demonstrated its ability to use available water power with such efficiency as to avoid the need of pumping by steam. The installation has also made it possible to repair an existing water-driven unit, so that the latter's efficiency is largely increased.

Willimantic, a city of 13,000 population, takes its water supply from the Natchaug River, intercepting its flow at a power dam behind which lies a drainage area of about 180 square miles. The original pumping equipment consisted of two units, one driven by steam and the other by a waterwheel. The waterwheel unit was about 40 years old and of an obsolete manufacture so that repair parts were not available. The steam pump was installed in 1895 by the Barr Engineering Company. These two units were later supplemented by a third, a 200-hp. Rodney Hunt cylindrical case waterwheel, which drove a duplex double-acting center-packed horizontal Worthington pump with a rated capacity of about 3 m.g.d. This unit was operated at a capacity of about 1.25 m.g.d. and both the pump and the waterwheel were sadly in need of repairs and adjustments.

As a part of studies of the situation all the pumps were rated by weir box and the Rodney Hunt wheel was rated for efficiency by a weir installed in the tail race with the result that the wheel efficiency proved to be about 63 per cent at operating rates. The waterwheel was actually operated under a load of about 100 hp. as against its rating of 200 hp. and this 50 per cent loading accounted in the main for the low efficiency and for the 70 sec.-ft. which was required as power to pump about 1.35 m.g.d.

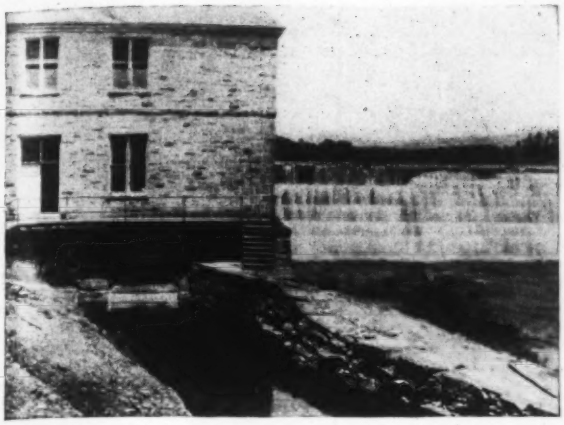
In 1915, the water consumption of the city was approximately 1 m.g.d. Between then and 1927 it increased to about 1.4 m.g.d., then dropped to 0.95 m.g.d., the later as the result of the installation of additional meters and of the reduction of flow of water to sewer flush-tanks. After studying the population curve and the pumpage records it was decided that in the next 30 years the population might increase to 20,000 people, and the water consumption go to not in excess of 1.4 m.g.d.

There was no opportunity for the repair or adjustment of either of the existing units. The waterwheel needed repair of wickets, thrust bearing, and adjustment of alignment, all of which gave rise to a very considerable leakage through the wheel when idle and contributed to the low efficiency of the wheel when in operation. The new unit was also demanded by the need for the most efficient use of the available water power during the dry months of the year and to save the increasing coal cost of pumping by steam. The coal costs for recent years had been an average of $3,700 per year and steam pumping had been necessary in recent years for an average of 81 days per year.



NEW WATERWHEEL-DRIVEN VERTICAL TRIPLEX PUMP FOR WILLIMANTIC WATER-WORKS

Double herringbone 220- to 53-r.p.m. reduction gear. Smaller of two sets of plungers and throats now in use give 1.5-m.g.d. capacity.



DAM, POWER HOUSE AND TAIL RACE OF WILLIMANTIC PUMPING STATION

Widening tail race and removing loose rock reduced velocity and increased head. Note smoothness of surface flow.

The obsolete waterwheel and the older water pump were removed and the tail-race conditions underneath the old waterwheel were remodeled so as to give a freer escapement from the draft tube. The area over the tail-race was floored over with steel-beam-and-concrete construction, extending from the old waterwheel foundations to the walls of the pump house, and the new wheel was set in concrete above this new floor. The tail race outside the pump house was found to cause a loss of head ranging from 12 to 18 in. during periods of low flow of the river. The bottom of the tail race consisted of ledge rock and it was not practicable to remove any large quantity of this ledge, but the race was increased in width and all loose material excavated, with the result that the tail race velocities for the new wheel were reduced to about 1.25 ft. per second. One of the accompanying views of the tail race was taken while the new wheel was in operation, and it will be noted that there is hardly a riffle in the surface of the water under flow conditions. The increased head due to the improvement of the tail race, together with the reduced velocity in this race has been a large factor in the success of the new unit.

The selection of equipment for the new pumping unit was necessarily based on the idea of efficiency for the waterwheel and space limitations for the pump. A vertical triplex pump was designed for the purpose, and a scroll-case Francis type of waterwheel for the power unit. The waterwheel was supplied by the S. Morgan Smith Company, and has a full gate power of 135 hp. with a flat efficiency curve between the ranges of 90 and 110 hp. and a maximum efficiency of 89 per cent at 100 hp., under 20 ft. effective head and at 220 r.p.m. The pump is a 14x12-in. single-acting triplex outside packed vertical plunger Worthington pump, designed to operate at 53 r.p.m. The reduction gear is of double herringbone type, reducing from 220 to 53 r.p.m. The pumping unit was designed for strength as a 14x12-in. pump, with a capacity of 1.75 m.g.d., but was supplied with a set of 13-in. plungers and throats with the result that at the same speed of 53 r.p.m. the output of the pump is 1.5 m.g.d. The pump is being operated at present with the smaller plungers and throats, but at any time there is need for a gradual increase in the capacity of the pump the 14-in. plungers and throats can be installed one by one to produce a maximum capacity of 1.75 m.g.d. without strain on any part of the pump.

The pumping unit, together with the necessary construction work at the pump house, was installed on labor account under the direction of the engineer. The pumping unit itself was purchased by the city and cost $14,375. Besides the new pumping unit, there was installed in the pumping station a master meter on the force main and a 10-ton crane which was needed not only for the old apparatus but practically paid for itself during the installation of the new equipment. A new 14-in. main was also installed to form a loop between the city and the distributing reservoir.

The new unit was thrown into service in March, 1927, and as soon as it had been run in, the old water-driven pumping unit was dismantled for repairs and reconstruction. The latter unit is now in prime condition and is used for all water conditions except summer flow, when the new unit is used for the smaller quantities of water.

Since March, 1927, it has not been necessary to use the steam pump, and the installation has saved the former annual coal cost, besides providing a spare water-driven unit available at any time of the year and demanded during the dry-flow months of the river.

Sluicing Débris From a Clogged Water-Power Conduit

THE flood following the collapse of the St. Francis dam near Los Angeles in March, 1928, carried large quantities of débris into the half-mile length of 9½x 12½-ft. tunnel the intake of which is just below San Francisquito power house No. 2. Because there is a sand trap and ample reservoir capacity at the lower end of this tunnel which would be available for settling out suspended matter, it was decided that the simplest and quickest means of removing the débris was by sluicing. This was done with the aid of a scraper drawn back and forth through the tunnel to loosen up the débris.

At the time of the flood, water flowed into this tunnel for a short period. When the flood subsided it was found that the tunnel was clogged with débris for its entire length of 2,400 ft., the depth of the deposit varying from about 9 ft. at the upper end (the tunnel height being 12½ ft.) to practically nothing at the lower end. The débris was chiefly gravel and sand containing a considerable proportion of large stones grading up to the maximum size that one man could lift. There was no broken concrete in the débris.

A 35-hp. double-drum gasoline hoist was placed at each end of the tunnel, and these were connected by a ¾-in. wire rope passed through the tunnel and fastened to two ½-cu.yd. scrapers mounted back to back so they would function as scrapers when hauled either way. This drag was used to stir the material with a small amount of water running continuously and then the tunnel was flushed out under the maximum flow that could be got into the partly obstructed upper end. After about two weeks' work it was possible to deliver 400 sec.-ft. through the tunnel, which was sufficient for operation at peak loads in the power plants below.

When this progress had been made the tunnel was considered available for service and thereafter the remainder of the débris was removed under ordinary aqueduct flow, this work being done by a small crew in intermittent periods which extended over about eight weeks.

The work was done under the direction of the construction department of the Bureau of Power and Light of Los Angeles.

Laying 20- to 60-in. Riveted Steel Pipe in the Greater Vancouver Water District

General Features of Design and Successive Steps in Field Engineering and Construction of Large Riveted Steel Pipe in Western Canada

By F. C. Stewart

Field Engineer, Greater Vancouver Water District, Vancouver, B. C.

Within the past four years the city of Vancouver and the surrounding municipalities composing the Greater Vancouver Water District have laid over 20 miles of 20- to 60-in. riveted steel pipe varying in thickness from $\frac{1}{4}$ to $\frac{9}{16}$ in. After briefly outlining the general features of design this article takes up in order the detailed field methods followed in laying the pipe, including adjustment to horizontal and vertical curves, and each step in lowering, fitting, jointing, testing and backfilling.

In manufacture and installation three general classes of pipes are recognized: standards, specials and bends. All are made of an even number of inner and outer courses. Standards are of four courses with a total length of from 24 to 28 ft., depending on the diameter and thickness. Specials are usually half-standards. Bends, both horizontal and vertical, are made in the shop for all angles over 2 deg. They are made of an even number of courses which are half or third plate lengths (about 2 or 3 ft. long), with deflections at each joint not exceeding 5 deg. They are made symmetrical with each deflection an even degree to simplify manufacture; that is, a 90 deg. bend would be made up of deflections as follows: 8 at 5 deg., 1 at 4, 1 at 2, 1 at 4, 8 at 5 deg. All rivet holes are sub-punched $\frac{1}{16}$ in. in the shop and reamed $\frac{1}{16}$ or $\frac{1}{32}$ in. over when pipe is assembled in place.

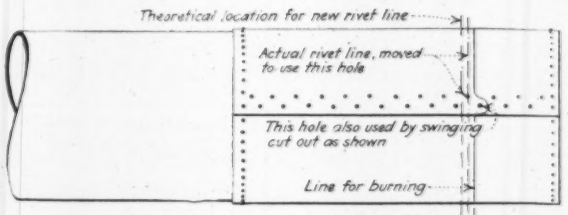

Theoretical location for new rivet line
Actual rivet line, moved to use this hole
This hole also used by swinging cut out as shown
Line for burning
Landing 4"

FIG. 1—METHOD OF FIELD CUTTING EMPLOYED

Practice in Vancouver has been to contract for the fabrication and installation of the pipe separately. No great difficulties have resulted, but in general there is less trouble in correlating the work when the pipe is manufactured locally than when it is imported.

Specifications call for the pipe to be dipped by the manufacturer, and the installing contractor is required to coat or recoat all abrasions, etc., with a first coat of primer and a final coating of enamel.

Trench Excavation—Outside the city, on private right-of-way, the top of the pipe is put only 1 or 2 ft. below the surface of the ground, but in the city a minimum of 3 ft. of cover is provided where there is apt to be any traffic. Specifications also call for excavating the trench to proper grade and line with a 9-in. clearance between the side of the trench and the pipe to insure

FIG. 2—LOOSE FITTING-LENGTH READY FOR JOINING TWO SECTIONS

FIG. 3—FITTING-LENGTH DRIFT-PINNED READY FOR RIVETING

proper backfilling and tamping. All pipe is laid directly on the bottom without blocking. This necessitates very careful grading in order to have the rivet holes come fair. For this reason, when the material is anything but gravel it is taken out by the steam or gas shovel as nearly to grade as possible without going too low. Line and grade stakes are then set in the bottom and the work is finished by hand and checked with boning rods. Where gravel containing boulders is encountered, the shovel digs below grade to take out all the boulders, and during trimming the bottom is built up to grade with the finer materials.

Field Engineering—To insure fair holes (which is essential to a good tight job), great care is exercised both in design and layout. For this purpose the following formulas were developed and used by the writer with good results. For deflections under 2 deg. whether vertical or horizontal, curves are used instead of bends, each field joint being deflected slightly. For vertical curves the maximum rate of change is given by the formula $RC = 600 \div L \times d$ and for horizontal curves the maximum degree of curvature by $D = 400 \div L \times d$, where RC = rate of change in per cent per hundred feet; D = degree of curve; L = length of pipe between field joints, i.e., length of standards, in feet; d = diameter of pipe in inches. Pipes are laid to such curves just as easily as on tangent and the holes fair up perfectly when reamed.

When a grade change and a horizontal deflection occur at or near the same place, their points of intersection are made to coincide, an ordinary horizontal bend is made in the shop and this bend rotated up or down as required to give the necessary change in grade. The actual deflection of the bend as made in the shop is determined by combining geometrically the horizontal and vertical deflections and calculating the actual angle of bend to lie on the given grades and give the required horizontal deflection. The bend is manufactured the same as a horizontal bend, and is such that when laid on a level floor a rivet hole occurs on its top center line. The rotation of this bend, or the "roll" of the top hole off the vertical center line to give the required grade change, or even to maintain the same grade past a horizontal bend, is given by the formula:

$$\text{Sin } R = \frac{\sin g_2 - \cos \Delta_a \sin g_1}{\sin \Delta_a} \sec g_1$$

where R = angle of rotation; Δ_a = actual bend angle as made in the shop; g_1 = grade of approach; g_2 = leaving grade. This formula applies to bends of equal semi-tangents. This operation usually necessitates redrilling, but as it is generally necessary (particularly in the city) to cut in order to bring the horizontal bends to their required position, this rotation involves no extra expense whatever.

After cutting and laying the last pipe before the bend, its top center line is determined by means of tape and plumb bob, and the top hole offset the required amount to give the necessary roll, or a distance $R \times d \div 2$, where R = angle of rotation as above and d = diameter of pipe.

The foregoing formula shows the folly of placing a vertical bend just before a horizontal bend of any appreciable magnitude, for regardless of the approaching grade, the leaving grade will be level or almost so if the bend is not rolled.

In laying out such a bend, the latitudes and departures of each joint of the actual bend are calculated from measured chord lengths and given deflections. The horizontal latitudes and departures are then obtained from the formulas: $l_h = l_a \cos g_1 - a_a \sin R \sin g_1$ and $a_h = a_a \cos R$, where l_h = horizontal latitude; l_a = actual latitude; g_1 = approaching grade; a_a = actual departure; a_h = horizontal departure.

The origin is at the beginning of the bend. The horizontal latitudes and departures being thus determined, the chord lengths and deflections from the beginning of curve are figured and laid out with transit and tape in the ordinary manner.

The elevation of any joint is given by the formula: El. = El. of P.C. + $l_a \sin g_1 + a_a \sin R \cos g_1$. Roll up is considered positive and down negative.

For use of bidders—both pipe manufacturers and laying contractors—a plan and profile is made. This is drawn to satisfy as nearly as possible street grade and alignment, but is entirely revised by the resident engineer as soon as a few pipes are made. Before starting the work he meets the laying contractor and decides at what point or points work will commence (usually at or near a 90 deg. bend in the city), and how it will proceed. He then makes his plan, using measured pipe lengths, standards and half-standards, working from the points of commencement toward the field cuts. In this he figures to bring the unimportant bends as nearly as possible to the position shown on the original plan without affecting the average excavation, and to place the important bends on exact location by cutting pipes in the field. The depth of excavation is never altered more than 3 in. from that shown on the original plan and the average is made the same.

Pipe Distribution—The pipes are delivered and distributed along the line in their required positions, as laid out by the superintendent from the engineer's stakes. They are hauled by truck and trailer. In unloading, skids and ropes are used to snub them down, to prevent injury to the coating.

A crew of four or five workmen in each laying gang is kept busy repairing the pipe coating and coating the field joints. Where damaged, the coating is scraped off, the pipe cleaned and recoated with a priming coat, followed by enamel. This is done ahead of each laying gang and one man is kept with each gang checking the pipes over just before they go into the ditch.

Pipe Laying—A gang of four or five men places the pipe in the ditch, joining it together with drift pins and bolts. The pins are much more useful than bolts, as they hold the joints more firmly and prevent slipping and blinding of the holes. Eight pins and often more are used in a joint on 36-in. pipe. When the first pipe is laid in the ditch a block is placed under its leading end. Then when the next pipe is connected, this block is moved forward, and so on. For this reason, the reamer, who follows the laying gang, never comes closer than about six joints from the end, as forward of this the joints give slightly as the end is lifted and lowered in moving the block. When the end of the pipe gets within five or six lengths of a field cut (usually at the beginning of a 90 deg. bend in the city), the exact distance is measured, and the cut figured and made. In this way the pipe is always ready, with three holes drilled in its top for connecting, before the laying gang is up to it, thus avoiding any delay. Two rivet crews and two calkers follow the reamer and finish the steel work, placing all valves, manholes and other appurtenances as they go.

Field Cutting—When a field cut is to be made, the exact length of pipe required is determined. This length is then laid off on the pipe to be cut, and gives the location of the new rivet line. When the position (vertical) of the top hole is of no consequence, that line is moved back or forward a little to make use of one of the existing rivet holes in the horizontal seam, as shown in the sketch (Fig. 1).

The line for cutting is then laid off as shown, allowing for the required landing plus $\frac{1}{4}$ in. The pipe is burned off to this line by means of the oxyacetylene torch, the quarter inch being chipped off afterwards to remove all burnt metal. The end of the plate at the longitudinal joint is heated and drawn out, or scarfed with chipping gun, where it fits to the next pipe. When the position (vertical) of the top hole is important it seldom happens that the rivet holes of the longitudinal joint will fit. In that case the cut is made straight and the two end rivet holes of the longitudinal seam filled, either by welding or by tapping out and screwing in a bolt which is cut off flush and riveted down. Before placing the pipe in the ditch, the top hole is located and drilled, as well as one on each side of it. Marks are also made on the bottom and sides of the pipe at the cut end, a distance back from the rivet line equal to the landing. In assembling, a pin is put in the top hole and a bolt each side of it. The pipe is lowered and entered until the marks above mentioned come even with the end of the pipe already connected. Laying then continues until two or three more pipes are down. The pipes are then lined up in the ditch, the position of the cut joint with reference to the "landing marks" checked up, and the remainder of the holes at this joint drilled through.

When pipe is laid by two gangs working toward one another, the method of connecting is as follows: All the pipe is laid except the connecting length. This connecting length is cut about 4 in. longer than required, by burning a piece off the outer course. It is then broken loose by cutting out all the rivets in the circumferential and longitudinal seams and the plate slipped back on the pipe about a foot. This gives clearance for lowering into place and connecting up, the pipe coating from the opposite direction, which is the next operation. The pipe in place with the course loose is shown in Fig. 2. This course is then cut to the exact length required, pulled forward, pinned and bolted up and the blind end drilled through and bolted up as shown in Fig. 3. Riveting and calking then follow in the ordinary manner.

After the joints are calked inside and out and inspected, the painters go through and clean the pipe out thoroughly, repair the coating where damaged and coat the field joints. Another man goes along outside cleaning the field joints and giving them a coat of priming only, to keep them from rusting until the test is made, when they are coated with the enamel.

Field Tests—Each pipe is tested separately before leaving the shop at a pressure 50 per cent higher than the working pressure for that particular thickness of plate, and the pipe line is tested in sections about one-half mile long at a pressure 50 lb. above the greatest static pressure that can occur. These tests are made, whenever possible, between line valves. No special end closing is then necessary and the laying is not affected in any way by the tests. However, very often this cannot be done, and the ends are then closed by riveting in test heads, which are ordinary tank heads made by the boiler works. A gage is placed on the line where it can be easily seen, and its elevation determined. From this and the high-water elevation of the reservoir, the static working pressure at the point is determined. The test pressure is applied by means of a gasoline- or air-driven pump.

FIG. 4—PROTECTING PIPE FROM BACKFILL

Just after the riveter is finished with a field joint, each rivet is hammer tested by the inspector to be sure that there are no loose rivets. During field test every joint is thoroughly examined and every weep or leak closed by calking. No measure of water lost is made. It is seldom necessary to take off the pressure to make repairs, but this can be done if a leak of any size is discovered. It might be well to mention here that the occurrence of numerous weeping rivets is usually a sign of insufficient air pressure during construction. A pressure of 100 lb. per sq.in. at the gun will usually give good results, but much less should not be allowed. Before filling the pipe an inspection is made to see that it is well supported at all points and has sufficient air valves in working condition to prevent the forming of air pockets in filling, or collapse in case of a blowout.

Following the test and prior to final backfilling, the painters go over the outside of the pipe, cleaning it off, repairing any damaged coating found, and finishing the coating of the field joints.

Backfilling—Before filling the pipe with water it is backfilled on the bottom about 6 in. up on one side and half way up on the other, leaving a low corner in the trench for drainage in case of heavy rain. This is staggered, high on one side of one pipe and on the other side of the next. Bellholes, of course, are not filled at all until after the test. Once water is put in the pipe it is not again emptied until the trench is backfilled, unless absolutely necessary. This prevents lifting or kinking due to temperature changes and floating in case of the trench becoming filled with water. The pipe being full, backfilling is commenced whenever possible—at the low points and worked up hill—keeping water in the trench all the time. This is found to consolidate the fill much better than by hand-tamping dry, and does less damage to the pipe coating, which is very carefully watched during backfilling. A backfilling machine or even team and scrapers do less damage to the coating than careful handwork, dropping the dirt on the slope and allowing it to run down. One man on the pipe just ahead of the fill then stops any rocks hitting it. When the backfilling is done by hand it is often necessary to place a cover over the pipe (Fig. 4). The dirt is thrown on this and runs down thus preventing the rocks striking the pipe directly.

Records Necessary to Insure Pumping Station Efficiency

By Charles D. Burdick
Alvord, Burdick & Howson, Engineers, Chicago, Ill.

LACK of knowledge of the detailed results obtained by pumping station operation is chiefly responsible for the widespread failure of water-works men to obtain the yearly efficiency of which their machinery is capable. Pumping stations in which the efficiency of the machine can be compared this week with last week, or this year with last year, are rare; usually something out of the ordinary must happen to attract notice to equipment, and then, very frequently, information is not at hand to make possible location of its deficiency. A proper system of records justifies itself by conveying information day by day as to total efficiency and by separating the different operations in the station so that defective operation can be located at once and a remedy applied before material loss has been incurred.

The writer has in mind a modern steam pumping station in which all essentials of daily operation are shown upon one letter-size sheet of paper. The information is divided into five general heads: water, fuel, boilers, efficiency and shift records. Pumpage, as indicated by a venturi meter, is shown for the day, both in total amount and in peak rate and minimum rate. Then follows the pumping head for the day, the average barometer, the average vacuum and the temperatures of air, water and condensing water.

Under "fuel" appears the total amount of coal used, subdivided into coal used in banking and in operation; the grade or trade name, the analysis in British thermal units per pound and the bin record of coal on hand at the beginning and at the end of the day. Coal used is weighed to the hoppers of the stokers. The heating value is obtained by analysis of a composite sample taken partly from each charge to the hoppers.

The boiler record includes steam pressure, superheat, steam temperature, average flue temperature, percentage of CO_2, average feed-water temperature, total water evaporated, water returned by the heating system, water used in operations, make-up water and temperature of the heating returns. Feed water is metered. Steam-flow meters on each boiler serve as a check on the feed-water measurement and also give the information as to the operation of the several boilers.

Under "efficiency" is listed the total coal duty of the station for the day in foot-pounds, the boiler and stoker efficiency in percentages, the steam duty of the pumps and auxiliaries and the coal burned per 1,000 gal. pumped.

At the bottom of the record sheet the performance of the boilers is shown as covering the three shifts of the day for purposes of comparison. These daily sheets are averaged and summarized on a monthly report. A summation of the monthly reports shows the annual performance of the station.

Installing Service Pipe in Quicksand

By Charles P. McGrath
Superintendent of Water-Storage Yards, Department of Water Supply, Detroit, Mich.

INSTALLATION of service connections between the water main and the lot line is a problem in Detroit because of the frequent presence of quicksand. Sheeting the trench is costly. Boxes of boiler plate proved unsatisfactory because of the thickness of plate necessary to withstand the outside pressure, the consequent weight and the trouble experienced in removing the box.

A satisfactory method which has gradually been evolved during the past few years makes use of well points. Six 1¼-in. well points 2 ft. long, are mounted on 1½-in. pipe 6 ft. long. These are connected to a manifold by pieces of 1¼-in. six-ply steam hose. The manifold, made of 2-in. pipe and fittings, has a 1¼-in. valve on each outlet so that any of the well points can be closed off when not required. The manifold is connected through a 3-in. hose to a hand-operated diaphragm suction pump. As the trench is dug, the well points are kept buried to prevent sucking air. Recently a gasoline-driven diaphragm pump mounted on a rubber-tired trailer has been acquired to replace the hand pump. Each of the service-connection trucks is provided with a trailer hook for attaching to a trailer.

By means of the well points three men can install a ¾-in. service connection 30 ft. long in four hours, against five men in from eight to ten hours under the old method.

Tulsa Building a 24-M.G.D. Water Purification Plant

Spavinaw Creek Supply to Be Aerated, Coagulated, Filtered and Chlorinated—Aerating Flume, Stilling Baffles and Filter Lateral System Are Unusual Features

By F. M. Veatch
With Black & Veatch, Consulting Engineers, Kansas City, Mo.

SHORTLY after having provided itself with a surface water supply of ample capacity for years to come but with no treatment except that noted farther on, the city of Tulsa, Okla., let a contract in January, 1929, for a complete purification plant. Besides changes which will give all, instead of a part, of the supply long-time sedimentation, the project provides aeration, coagulation, filtration and final chlorination. The plant includes a number of interesting features, chief of which are aeration before coagulation, through porous plates set in a supply flume, a slotted stilling baffle in the coagulating basin and brass filter underdrain laterals with two rows of impact orifices, the latter like those in use in New Orleans. The plant will have an initial rated capacity of 24 m.g.d.

Since October, 1924, the city of Tulsa, Okla., has been supplied with water impounded in Spavinaw Creek and delivered to a 500-m.g. storage reservoir, known as Mohawk Lake, through a 54- and 60-in. concrete conduit, 55 miles long. From Mohawk Lake the water is pumped about 4 miles to the city. (The Spavinaw project, which cost approximately $8,000,000, was described in *Engineering News-Record*, May 8 and Oct. 30, 1924, pp. 221 and 723. The earlier history of the Tulsa water-works is given in the issues of Aug. 1, 1918, p. 221, and Nov. 3, 1921, p. 719.) The need of water purification was made apparent shortly after the completion of the Spavinaw project, by occasional periods of moderate turbidity and fairly constant trouble due to color and odors. Steps to provide treatment were taken in 1927. An investigation was made and a report was prepared, which resulted in the decision to construct a purification plant.

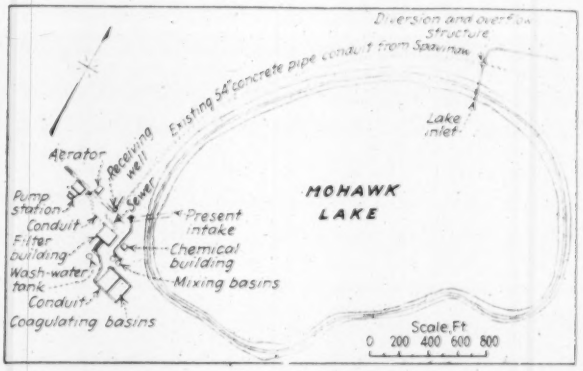
The quality of the Spavinaw water varies slightly during the year, but is approximately as shown by a sample collected in July, 1926:

	P.P.M.
Iron, aluminum and silica (very little iron)	3.0
Calcium	31.3
Magnesium	2.2
Sodium	4.5
Chlorides	6.8
Sulphates	5.3
Bicarbonates	100.0
Temporary hardness	87.3
Permanent hardness	0.0
Total hardness	87.3

The turbidity is ordinarily 10 p.p.m. but occasionally reaches 300 p.p.m. for short periods. The color runs from 10 to 20 (platinum-cobalt standard).

With a population of 130,000 in 1926, and the system fully metered, water consumption averaged 12.5 m.g.d., or about 96 gal. per capita. The corresponding maxima were 18 m.g.d., or 134 gal. per capita. The increase in consumption from 1925 to 1926 was 3.28 m.g.d. The treatment plant herein described is designed for a capacity of 24 m.g.d. at normal rates. Provision is made for enlargement to 80 m.g.d.

At present water from the Spavinaw conduit is discharged into a high-service suction well. The excess flow is diverted into Mohawk Lake and held for storage. A separate suction line leads from the high-service pumps to an intake well in Mohawk Lake to enable this storage to be used at times of high turbidity in the Spavinaw water or in case of emergency. Since the water enters and leaves Mohawk Lake through the intake structure, there is no general movement of water in the lake other than that induced by wind. Chlorination is the only



LAYOUT OF TULSA WATER-TREATMENT PLANT

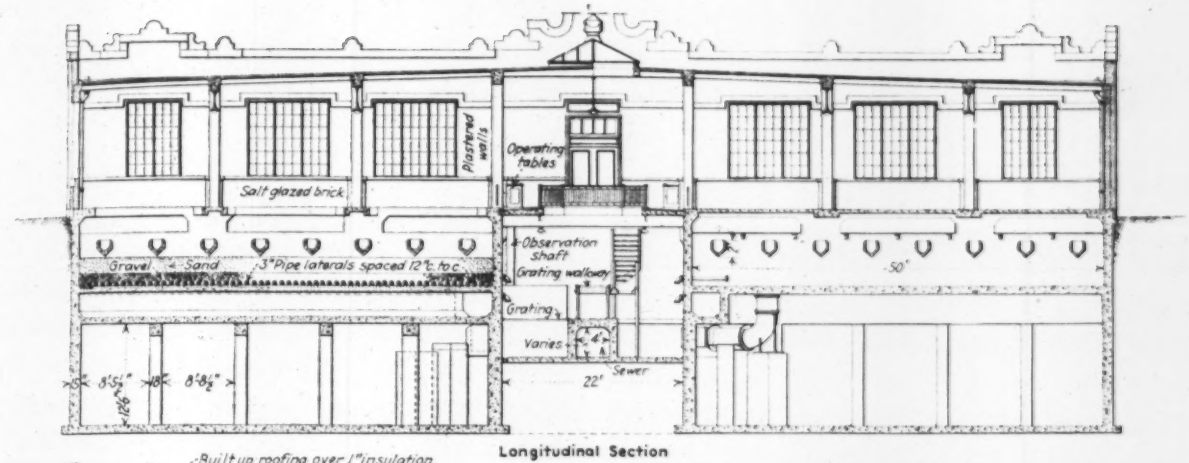
treatment now given to the water, aside from that afforded the portion which is stored in the lake.

Provision will be made for the continuous use of the entire area of Mohawk Lake, or 180 acres, for plain settling. The settled water will be aerated by means of compressed air, introduced through diffuser plates set in the bottom of the flume which connects Mohawk Lake and the treatment plant, coagulated by the use of lime and alum and filtered through six rapid sand filter units, each with a nominal capacity of 4 m.g.d. The final effluent will be chlorinated.

A diversion and overflow chamber will be located on the Spavinaw conduit near the lower end of Mohawk Lake at a point remote from the existing intake. Water from the conduit will be let into the lake at this point to make its settling capacity available. At present the lake can be operated only on the fill-and-draw plan.

A diversion chamber will be built on the existing 54-in. line between the receiving well and the intake structure in Mohawk Lake. This chamber will be used as a main inlet to the purification plant proper, and water may be taken direct from the conduit through the receiving well or from the lake. Space is provided for future low-service suction connections.

A concrete raw-water flume 6½ ft. wide, with a water



SECTIONS THROUGH TULSA WATER FILTERS AND EQUALIZING CLEAR-WATER RESERVOIR

depth of approximately 6 ft., will extend from the diversion chamber past the coagulant house to the mixing tanks. A metal stop gate will be located at the upper end of this flume. Space is provided for future low-service pump discharge pipes just beyond this gate. Due to the fact that it is desired to operate the plant by gravity and since the available head is limited, the raw-water flume is designed for a flow of 120 m.g.d. and will serve for partial mixing, since the diffused air to be used for aeration will be delivered through plates set in the bottom of this conduit.

Due to lack of head, aeration will be accomplished by diffused air supplied through Filtros plates set in the bottom of the raw-water conduit. Air will be furnished by two motor-driven blowers, each with a capacity of 300 min.-ft. of free air at a head of 5 lb. The air will be discharged through 210 grade R Filtros plates set in 42 precast concrete plate containers laid transversely on 2-ft. centers on the bottom of the flume.

Two mixing basins, each 40 ft. in diameter and from 16.5 to 22 ft. deep, will be provided. The aerated water, with the chemical charge added, will enter each basin tangentially through a vertical slot 12 in. wide and 7 ft. high. The velocity necessary for mixing will ordinarily be obtained by the flow of water itself, but to conserve head and to increase the velocity when necessary, water from the high-pressure mains will be discharged in the direction of water flow through three 2x⅜-in. nozzles set on headers located near the walls of the basins. After mixing, the water will leave the basins through an opening in the center and will be discharged into a large flume which extends along the inlet end of the coagulating basins. Each of the mixing basins has a capacity of 0.183 m.g. When operated together the basins allow a fifteen-minute mixing period, at a rate of 36 m.g.d. or a 22-minute period at a rate of 24 m.g.d.

There will be two coagulating basins, each 151x102 ft. in plan and from 6.5 to 14 ft. deep, with a combined capacity of 3 m.g. This represents a detention period of three hours at a rate of 24 m.g.d. and two hours at 36 m.g.d., which periods, while low, are justified by the fact that a settling period of from 14 to 21 days is available in Mohawk Lake. Water will enter these basins from the inlet flume through sixteen 30-in. square sluice gates and will be drawn off over an outlet weir and admitted to the effluent flume through four 36-in. square sluice gates. The influent and effluent flumes are both 6 ft. wide and have an average water depth of 6 ft. A slotted stilling baffle formed of 8-in. planks, set vertically with 2-in. open spaces and supported on an "A" frame, will be placed transversely in the basin 50 ft. from the inlet end. All the sluice gates will be hand operated from valve stands mounted on the wall. The bottom of each basin will slope to a central trough, drained by 16-in. cast-iron pipe. For use in cleaning, a 6-in. high-pressure water line with two standard fire hydrants will be laid along the north and west sides of the basins.

The basins will be constructed on a bed of shale that drops off abruptly near the south and east sides of the east basin, and to save expensive excavation the basin walls will be of the cantilever type for a depth of 6.5 ft. (below water level) and the basin below this depth will be sloped and paved. At points where the shale bed dips below the foundations, the floor slabs will be carried by beams and columns which extend to a solid foundation.

The settled water will be conveyed from the basins to the filter plant by a concrete conduit 8 ft. wide and 6 ft. deep, which will have two branches 6 ft. square, each of which leads to one bank of filters. Each of the branches terminates in a cast-iron line from 54 to 30 in. in diameter, which will serve as an influent line for three proposed and two future filter units.

Filter Plant—There will be six gravity filter units, each with a surface area of 1,400 sq.ft. and a normal capacity (at 2 gal. per square foot per minute) of approximately 4 m.g.d. The filter piping and appurtenances have, however, been designed with the view of operation at a rate of 6 m.g.d. if necessary.

The filters will be of standard design except that the underdrain system will be made up of 2½-in. brass laterals with two parallel rows of "impact orifices," set 60 deg. apart and with eight orifices per foot. This underdrain system is similar in general to those in use at New Orleans and was designed by Eugene F. Delery. The filter house will be of brick, 102x106 ft. in plan.

A clear-water reservoir with a capacity of about 1 m.g. will be located directly beneath the filters. This will be used for equalizing the pump and filter operation, but not for storage, since the city now has a 10-m.g. storage reservoir in operation on the distribution system.

A chemical house, 53x38 ft. in plan, will be located adjacent to the raw-water conduit. The office, laboratory, chemical feeding equipment and air blowers will be located on the first floor of this building. The second floor will be used for chemical storage, locker room, shower bath and lavatory. Two machines for feeding hydrated lime and two lump alum-feeding devices will be installed, all with hoppers which extend to the second floor, where the charging will be done. Since clarification only is desired, the ordinary treatment will require approximately 1,500 lb. of alum per day. Lime will not be required ordinarily, but may be needed occasionally.

A 5x5-ft. concrete conduit, which terminates in a pump sump, will be provided to convey the filtered water from the plant to the existing pumping plant. Chlorine will be applied in the pump sump.

Water for filter washing will be stored in a steel tank 32 ft. in diameter and 23 ft. high, located on high ground south of the filters. This tank will be inclosed in an ornamental brick casing, octagonal in shape.

Plans and specifications were prepared by Black & Veatch, consulting engineers, Kansas City, Mo., in collaboration with Victor H. Cochrane, of Tulsa. These engineers have general supervision of the construction work, which is in direct charge of the Tulsa Engineering Department. A. Endicott is commissioner of waterworks and William Anderson is superintendent. The architectural designs were prepared by H. H. Mahler & Company, of Tulsa.

Anchoring a Wood-Stave Pipe in Sliding Ground

By S. C. Watkins

Superintendent, Water Department, Aberdeen, Wash.

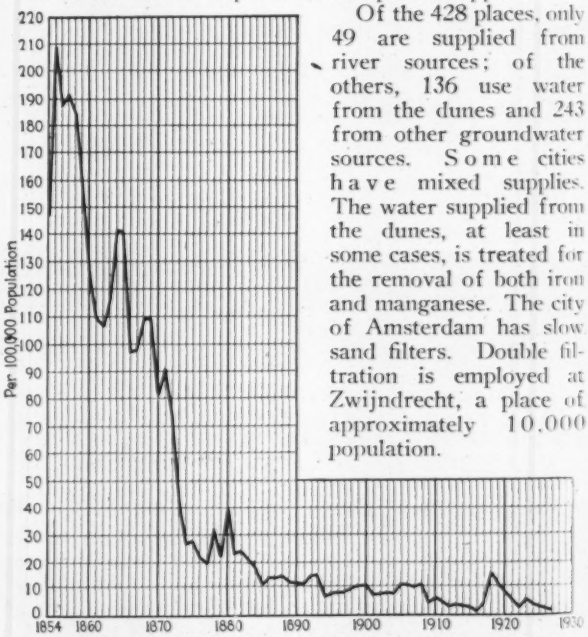
WATER for Aberdeen, Wash., is brought to the city through a 28-in. continuous wood-stave pipe line 22 miles long. When this was built, in 1915, about 300 ft. was located across an area which showed evidences of having been in motion within the past century. Inasmuch as relocation to avoid this slide would have required 2,000 ft. of pipe and a tunnel and as the area seemed to have been stable for about 50 years, the location was not changed. The line crossed the slide area diagonally at about a 25 deg. angle. No trouble was experienced until 1921, when a slight movement took place, resulting in a small break in the pipe line. Repairs were made and no more trouble followed until 1923, when a second small movement took place. In December, 1925, a serious movement occurred, breaking the supply line in two places. As it was evident that further trouble would be had with the line from time to time, it was decided to anchor the pipe by a cable and at the same time to provide for the movement of the slide without disturbing the pipe.

For the length of the slide, a trench 2 ft. wider on each side than the pipe was dug to a depth 18 in. below the bottom, with earth supports left at intervals. A longitudinal mud sill was then laid, consisting of two 3x12-in. planks with a third plank centered above them. Across this platform rollers made of 6-in. steel pipe were laid at 5-ft. intervals. On the rollers a fourth plank was laid longitudinally. This system was brought up snugly against the pipe by wedges and the temporary blocks of earth were removed. For anchorage, a 1½-in. plow-steel cable was securely lashed to the pipe at the lower end of the slide, then carried along the top of the pipe across the slide and beyond it to the crest of the hill, where an anchorage was made and the cable securely fastened to it by means of turnbuckles. At 10-ft. intervals the cable was fastened to the pipe.

In the several years which have elapsed since this installation the slide has moved almost continuously during the winter months, but the pipe, held by the cable, has remained in place, while the ground has slid or rolled under it. The only maintenance necessary has been an occasional retightening of the wedges under the planks so as to maintain support.

Public Water Supplies of Holland Serve 60 Per Cent of Population

PUBLIC water supplies for 70 cities and 358 rural towns had been provided in Holland on Jan. 1, 1928, according to a recent publication of the Bureau of Water Supply of that country, written by W. F. J. M. Krul, director and F. A. Liefrinck, engineer. Although there were 428 cities and towns supplied, the number of waterworks systems was only 135. Of these, 98 were publicly and 37 privately owned. There were some regional supplies. The 428 cities and towns with public water supplies include 60.5 per cent of Holland's population of 7,600,000. The average daily per capita water consumption for the year 1927 was 98½ liters (26 U. S. gal.). Most of the industrial plants have separate supplies.



TYPHOID MORTALITY IN AMSTERDAM, 1854 TO 1927
Public Water Supply Put in Use in 1853.

Of the 428 places, only 49 are supplied from river sources; of the others, 136 use water from the dunes and 243 from other groundwater sources. Some cities have mixed supplies. The water supplied from the dunes, at least in some cases, is treated for the removal of both iron and manganese. The city of Amsterdam has slow sand filters. Double filtration is employed at Zwijndrecht, a place of approximately 10,000 population.

News of the Week

Tube Across City and East River Proposed for New York Traffic

Mayor Recommends Project Costing $105,000,000 — Second Tunnel to New Jersey May Connect

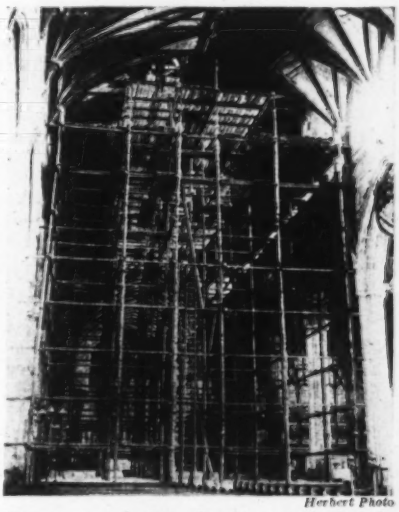
CONNECTION of Brooklyn and Queens with Manhattan by means of a vehicular tunnel under the East River, which would be extended almost the entire width of Manhattan, has been recommended in a preliminary report submitted to Mayor Walker, of New York City, and by him transmitted to the Board of Estimate for consideration. The partial report was prepared by Day & Zimmermann, who were engaged several months ago to make a comprehensive traffic study and to recommend relief measures for the city. The project, which would cost approximately $105,000,000, includes double tubes under 38th St. from Tenth Ave. across the mid-section of Manhattan to Long Island City, with a branch exit connecting with Brooklyn, on the opposite side of Newtown Creek. This would be intersected by right-angle approach tunnels to accommodate traffic reaching the tubes from the north and south. One of these would be at Tenth Ave., the other at Third Ave. These approach tunnels, according to preliminary plan, would be double-decked to accommodate traffic in both directions. Similar approach tunnels are provided at both the Brooklyn and the Queens terminals, but these remain optional, pending a decision as to the amount of money available for the project. By modification of the plan, it would be possible to bring the total cost down to $86,000,000.

Inclusion of the crosstown section of the tube eliminates objections previously voiced against plans for a midtown tunnel under the East River, which held that the present street system would be unable to accommodate the increase in crosstown traffic which would result in this already congested district. The report declares that the tunnel would accommodate at least 19,000,000 vehicles a year, which, at an average toll charge of 50c., would yield revenue to provide for maintenance and the ultimate return of the investment to the city.

New Jersey Connection Advised

Immediately after the announcement of the project had been made, a joint statement was issued by the tunnel commissions of New York and New Jersey stating that the construction of a second Hudson River vehicular tunnel would again be recommended to the state legislatures at the next session. The second tunnel is planned to cross the Hudson at approximately the same part of New York City and could easily be connected to the proposed crosstown tunnel, giving a direct underground route from New Jersey to Long Island. The announcement states that the present Holland tunnel is rapidly approaching capacity and will soon be inadequate to meet the increased demands of the vehicular traffic under the Hudson. The second crossing, which is entirely independent of the New York-Brooklyn plan, has been proposed to the two legislatures once before, but no action was taken.

REPAIRING ENGLISH CATHEDRAL



Herbert Photo

Ravages of the death watch beetle have so weakened the roof rafters of Boston Stump, the medieval cathedral at Boston, Lincolnshire, England, that extensive repairs are necessary. This photograph shows the scaffolding necessary in the nave of the cathedral in order to replace the weakened timbers.

Merrill Resigns to Head World Power Conference Section

O. C. Merrill, executive secretary of the Federal Power Commission, announced June 7 that he had submitted his resignation to the commission, to take effect July 1. Mr. Merrill will become head of the recently reorganized American section of the World Power Conference, which has been placed on a permanent basis, with offices in Washington and New York City. The latter, however, will not be opened until Mr. Merrill's return from the World Engineering Conference in Tokyo this fall. He will be assisted by Pierre Grosheintz, a Swiss engineer who has been associated with the World Power Conference for a number of years.

Russia Seeks American Technical Aid in Large Rehabilitation Program

Improvements Are Planned Totaling $38,000,000,000—American Contracts Reported Signed

UNCONFIRMED reports from Moscow, U.S.S.R., state that the Soviet government has announced that a number of contracts for technical assistance have been signed by Soviet officials with American firms and individuals. Russia has plans pending for the expenditure of $38,130,000,000 in rebuilding Russian industry and agriculture within the next few years. It is believed that through the retention of American engineering experts the Russian government expects to form a business connection with the United States which will aid in obtaining diplomatic recognition by this government.

The announcement from Moscow names the following contracts as being already consummated:

Hugh L. Cooper Company, New York City, for the planning of a $100,000,000 hydro-electric power plant in the Ukraine.

Stuart, James & Cooke, New York City, for opening new coal mines, rebuilding old ones and the installation of modern equipment.

H. J. Freyn Engineering Company, New York City, for the design of steel mills to cost more than $1,000,000.

Radio Corporation of America for the exchange of patents and other technical information.

International General Electric Company for technical assistance and exchange of patents.

Nitrogen Engineering Company, New York City, for technical assistance in erecting a nitrogen fertilizer factory.

E. I. du Pont de Nemours & Company, Wilmington, Del., for technical assistance in erecting ammonia fertilizer factories.

Longacre Engineering & Construction Company, New York City, for technical assistance and supervision in the construction of apartment houses in Moscow.

Arthur P. Davis, Oakland, Calif., for services as chief consulting engineer on irrigation projects in Central Asia.

McCormick Company, New York City, for the design of a large baking plant in Moscow.

Albert Kahn, Inc., Detroit, Mich., for the design of a tractor factory to produce 40,000 units annually, at Stalingrad.

During the past few weeks a number of reports have been published relating to alleged American contracts with the

Russian government. Included in these are the contracts of the Rosoff Subway Construction Company, New York City, for the construction of a 12-mile belt subway and a 120-m.g. water-works system for Moscow; a contract with Henry Ford for the erection of a factory to produce 100,000 cars and trucks annually; and the engagement of Lyman E. Bishop, consulting hydraulic engineer, of Denver, Colo., as consulting engineer for irrigation works in Soviet Turkestan. The latter report has been confirmed by Mr. Bishop. It is understood that the contract with the Rosoff Subway Construction Company will not be completed until the company has succeeded in negotiations to obtain the required capital from outside sources.

Pratt Now Consulting Engineer for Jersey Water Board

By abolishing the position of chief engineer, the North Jersey District Water Supply Commission on June 5 removed Arthur H. Pratt from that post. He will be retained as consulting engineer on a monthly basis, reducing his salary from $15,000 to $6,000 a year. Mr. Pratt has been chief engineer of the commission since July, 1919. He supervised the design and construction of the Wanaque reservoir and also designed the concrete and steel single pipe line for the Wanaque aqueduct. However, he was removed from control of the aqueduct about a year ago, and a plan for twin steel pipes substituted. Construction of the aqueduct and pumping station was then placed in charge of Fuller & McClintock, and Mr. Pratt was informed that his duties would be confined to studies and reports on water problems of the district. As consulting engineer his duties, as specified by the commission, will include the preparation of the annual report for publication and the supervision and continuation of the Passaic Valley inventory. Mr. Pratt states that he will also apply himself to private practice.

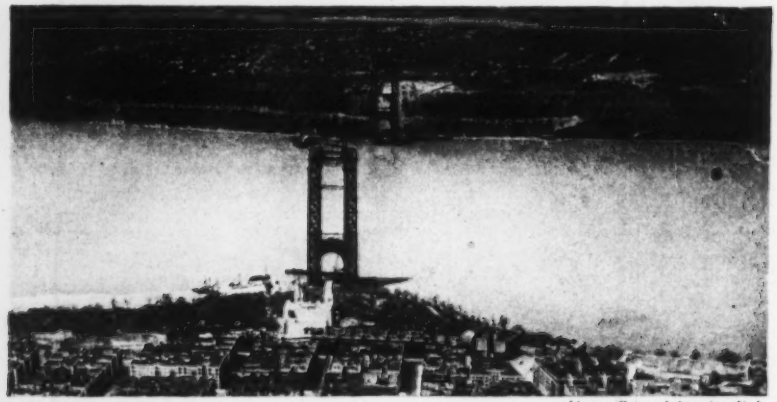
Engineers to Test N. Y. Multiple Dwelling Act

Proceedings to test the validity of the multiple dwelling act, which forbids licensed engineers from filing plans for construction or alteration for any housing building, have been initiated by the New York State Society of Professional Engineers and Land Surveyors. On May 29 plans were filed by Oscar Goldschlag, a licensed professional engineer, for a six-story apartment house to be located in New York City. These plans were refused by the Tenement House Department. It is the intention of the society to apply for a mandamus to force the Tenement House Department to accept the plans, which, under the terms of the law, can be filed by a registered architect only. It will be contended that the act is a direct violation of the Constitution because it deprives the engineer of his right to practice his profession, and also that it nullifies the professional engineers' law, which gives the right to practice in the state to registered engineers.

Survey for 9-Ft. Mississippi Channel Authorized

A survey to determine the practicability of a dependable 9-ft. channel in the Mississippi River between the mouth of the Illinois River and Minneapolis, Minn., has been authorized by the board of engineers for rivers and harbors and Major Gen. Edgar Jadwin, Chief of Engineers. The latter has appointed the following board of officers of the Corps of Engineers for this purpose: Brig. Gen. Thomas H. Jackson, president of the Mississippi River Commission; Lieut. Col. George R. Spalding, district engineer at Louisville, Ky.; Lieut. Col. Wildurr Willing, recently appointed district engineer at St. Paul, Minn.; Major Charles L. Hall, district engineer at Rock Island, Ill.; and Major John C. Gotwals, district engineer at St. Louis, Mo.

AERIAL VIEW OF HUDSON RIVER BRIDGE TOWERS



Airmap Corp. of America, N. Y.

Work on the steel towers for the Hudson River suspension bridge connecting New York City with Fort Lee, N. J., is practically completed except for minor details. This photograph, taken from the air on the New York side, shows the two towers and the massive concrete anchorage, not yet completed. It is interesting to compare the size of the towers and anchorage block with the six- and seven-story apartment houses adjacent.

Brief News

DAMAGES TOTALING $100,000 are sought from Kingsville, Ont., in six lawsuits on account of deaths from typhoid fever in an epidemic occurring in 1927 which numbered 60 cases and ten deaths. One claim alone was for $30,000 made by a husband for the death of his wife. The cases are being tried without a jury.

A BILL REQUIRING the consent of the Canadian Parliament to the exportation of power was defeated by the Senate May 28. As the law now stands, power can be exported under license from the government without the necessity of parliamentary assent.

AN INSPECTION of the upper suspension bridge at Niagara Falls has been made by the Canadian Board of Railway Commissioners, following rumors that the bridge was in dangerous condition. The report states that the structure is free from excessive sway and in thoroughly fit condition.

THE SUIT of the Strauss Engineering Corp., of Chicago, against the city of Seattle in the federal court for alleged infringement of its patent rights in the construction of the Montlake bascule bridge has been dismissed for lack of prosecution.

OPENING OF THE NEW PASSENGER TERMINAL of the New York Central Railroad in Buffalo, N. Y., will take place June 23. The main building is 300x225 ft. in plan, and 100 ft. high. It is surmounted by an octagonal tower 271 ft. high housing fifteen floors of offices.

THE HUNDREDTH ANNIVERSARY of the founding of a professorship of civil engineering at the University of Vermont will be celebrated at the annual dinner of the college of civil engineering to be held June 15.

COUNTY SUPERVISION of garbage collection has been started by Arlington County, Va., which has closed a contract for weekly collections at every house in the county desiring such service. A charge of $2.50 per quarter will be levied by the county on those who use the service. Of this amount 10 per cent will be retained to cover supervision and accounting, the remainder to be turned over to the contractor.

THE RECENT REVOLUTION in Mexico resulted in damage amounting to about $15,000,000 to the property of the National Railways of Mexico. This includes torn up track, dynamited bridges and other damaged property throughout the republic.

APPLICATION FOR AN INJUNCTION against completing the construction of a city refuse incinerator on East 57th St., Borough of Brooklyn, New York City, has been denied. The court held that such an undertaking should not be stopped on affidavits alleging prospective nuisance and property damage.

University of Cincinnati Makes Schneider Its President

Dr. Herman Schneider, dean of the School of Commerce and Engineering of the University of Cincinnati and acting president of that institution for the past year, has been elected president by the board of directors.

Electrical Industry Holds Annual Convention at Atlantic City

Tribute to Thomas A. Edison, the man who made possible the electrical industry as it exists today, was the keynote of the annual convention of the National Electric Light Association at Atlantic City, N. J., June 3-7. The fact that this year marked the 50th anniversary of the invention of the incandescent electric light provided the occasion for a notable celebration, "Light's Golden Jubilee," which extended over the entire city. Special street lighting, show window displays, the outlining of buildings by electric lights, a great arch of jeweled lights crossing the Boardwalk, and colored searchlights combined to make an effect which was highly impressive.

While most of the addresses presented to the convention dealt with problems relating to the electrical industry, there were a number of more general interest. The committee on electrification of railways, Britton I. Budd, chairman, presented a report stating that at the present time electric power has been adopted by railroads in 29 different countries of the world. About 10,000 of a total of 600,000 miles of line are now electrified, constituting 1.67 per cent. Switzerland has the highest proportion of lines electrified, 43½ per cent, while in this country only about 0.75 per cent of the total mileage is operated electrically. Viewed from the standpoint of actual miles electrified, however, the United States has 1,900 miles, Switzerland 1,500 and Italy and Germany approximately 1,000 each. Twenty railroads in the United States have some electrical operation. The length of route electrified is, as stated, 1,900 miles; the total length of track 4,300 miles.

In a paper on the subject of railway electrification George Gibbs, consulting engineer, of New York City, discussed the problems to be solved in changing from steam to electric operation. He stated that electric haulage has been thoroughly tried out for every condition met with on steam railways and that it has proved reliable and useful from an operating standpoint. However, the high first cost of electrification has retarded its progress and has limited it to use on roads with very dense traffic or under peculiar and favorable conditions, such as heavy grades and loads.

Officers elected by the association before its adjournment included the following: president, M. S. Sloan, New York Edison Company; vice-presidents, J. F. Owen, Oklahoma Gas & Electric Company; Marshall E. Sampson, Central Illinois Public Service Company; Edward F. Gruhl, North American Company, and Percy F. Young, Public Service Company of New Jersey. A. Jackson Marshall, of New York, was re-elected secretary, and Paul F. Clapp, also of New York, was reappointed managing director. The Charles A. Coffin award for 1929 went to the El Paso (Tex.) Electric Company for achievement in the industry.

Western Society Holds 60th Annual Meeting

With the annual dinner on June 5, the Western Society of Engineers closed its 60th year and started on a new year of professional activity. An address on "Engineering Education and its Future," by William E. Wickenden, president of the Case School of Applied Science, was the main feature of the program. Honorary membership was conferred on Edward C. Carter, consulting engineer and past-president. Certificates of presidentship were given to 22 past-presidents, of whom twelve were present and for whom a brief response was made by Onward Bates. The Robert W. Hunt prize was awarded to D. T. Waby for his paper on "Iron and Steel Melting in the Electric Furnace." There was no award of the Chanute prize. A rather brief address by the retiring president, John A. Garcia, reviewed the society's activities of the past year and offered some suggestions as to the future. The attendance to the dinner was about 500.

Officers elected for 1929-30 are as follows: president, William S. Monroe (president of Sargent & Lundy, consulting engineers); vice-presidents, D. J. Brumley (Illinois Central Railroad), W. O. Kurtz (Illinois Bell Telephone Company) and Frank D. Chase (of Frank D. Chase Company, industrial engineers); treasurer, Leigh S. Keith (re-elected); secretary, Edgar S. Nethercut (re-elected). For the several technical sections the chairmen are as follows: bridge and structural engineering, Albert Smith, structural engineer; electrical engineering, P. B. Juhnke, Commonwealth Edison Company; gas engineering, E. A. Dieterle, consulting engineer; hydraulic, sanitary and municipal engineering, W. W. De Berard, associate editor, *Engineering News-Record*; illuminating engineering, Alfred Herz, Public Service Company of Northern Illinois; mechanical engineering, F. W. Martin, Sargent & Lundy Company; railway engineering, W. S. Lacher, Western editor, *Railway Age*; telephone, telegraph and radio engineering, John H. Miller, Jewell Electrical Instrument Company. At present the society has about 3,240 members.

To encourage the writing of papers by young engineers the society has established the "Charles Ellet award" for its junior members. This takes the form of a silver cup on which will be engraved each year the name of the junior member presenting the best technical paper, the cup remaining permanently on exhibition in the society's office and a certificate being given to the prize winner.

Start to Condemn Land for New Madrid Spillway

The first of approximately 90 condemnation suits for the acquisition by the federal government of land required for the construction of the proposed setback levee between Bird's Point and New Madrid, Mo., was filed in St. Louis, Mo., June 4. These suits, seven in number, have been brought under authority of the national flood-control act passed by Congress to prevent a recurrence of the floods of 1927. They will be transferred to the Southern division of the U. S. District Court at Cape Girardeau for the appointment of three commissioners who will determine the value of the land to be taken for the floodway.

Chicago Sanitary District to Get $27,000,000 Bonds

During its closing days the Illinois Legislature passed the bill permitting the Sanitary District of Chicago to issue bonds for $27,000,000 without a referendum. Under a recent law, all such bond issues must be submitted to public vote, but in view of the financial shortage of the district and the hostile attitude of the public, it was feared that approval could not be obtained for raising money to carry on extensive works already under construction. The district had asked for $40,000,000, but the legislature cut this to $27,000,000 as being quite sufficient to take care of the present emergency. A bill to put the district's employees under civil service rules was defeated.

Los Angeles Defeats Bond Issue

At a special election held June 4 the voters of Los Angeles, Calif., defeated two bond issues aggregating $40,000,000, for the purpose of municipal water and electric construction. Full details regarding these issues were given in *Engineering News-Record*, May 30, 1929, p. 886. A two-thirds majority was required to approve the issues. The final vote on the water bond issue of $22,500,000 was: yes, 147,335; no, 86,981. On the power bond issue, amounting to $17,500,000, the vote was: yes, 110,149; no, 109,510.

Kentucky City Manager Act Declared Unconstitutional

A decision declaring the city manager act passed by the Kentucky Legislature in March, 1928, unconstitutional was handed down May 31 by the Kentucky Court of Appeals. The law, which authorized cities of the second class to adopt the city manager form of government, was attacked on three grounds: (1) that it violates the constitutional provision that stipulates the mayor shall be the chief executive; (2) because it allows an authoritative position to be appointive rather than elective; and (3) because the title of the act was faulty.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

A.G.C. to Hold Trade Practice Conferences—Good Upholds Jadwin—Alaskan Development

FOR THE PURPOSE of eliminating unsound practices from the construction industry, the allied construction industries committee, representing the Associated General Contractors and eleven organizations of subcontractors, has resolved to go through a series of trade practice conferences with the Federal Trade Commission. Although each of the subcontractors' organizations will have a separate hearing before the commission, the full committee will endeavor to standardize the material to be taken up. It is planned to accomplish this by having each of the groups submit a draft of its recommendations to the committee before the commission's stamp of approval is sought. In this manner the best thought of each of the groups will be placed at the disposal of the others and the industry as a whole will receive the benefit of a more or less standardized code of practices. Particular attention will be directed, it is stated, toward preventing the practice on the part of some contractors of shopping around for cheaper bids among their subcontractors after they have secured an award. It is believed that the adoption of a trade agreement restricting the extension of credit to contractors and subcontractors who indulge in this practice will be a great aid in abolishing the evil.

No Agreement Reached on Colorado Water Division

The tri-state conference on the division of Colorado River waters from the Boulder dam project was carried through to the first of this week without an agreement yet being reached. William J. Donovan, chairman of the conference, has been striving to bring about a compromise through executive sessions attended by a limited number of delegates. One plan which was submitted made for the division by means of a formula rather than by specific quantities which would vary from year to year according to the river flow. After extended discussion behind closed doors, this was tabled. On June 12 George W. Malone, commissioner for Nevada, offered a new set-up for division of the lower basin water. On that date it seemed probable that the conference was about to adjourn for an indefinite period and to study this proposition pending another meeting. Briefly, the proposal gives Arizona 1,000,000 acre-ft. from the available surplus and sets up a basis for division of the remainder.

The statement that the construction of Boulder dam is assured because of the expressed readiness of the Los Angeles Bureau of Power and Light to purchase all the incidental power that may be generated is characterized as propaganda by Representatives who opposed the passage of the act. They point out that the municipal electric company will be obliged to spend $60,000,000 for the construction of transmission lines. This, they hold, the company cannot do before it has put the matter up to the voters. They hold also that the company must obtain permission from the California Legislature before it can increase its debt.

Because of these conditions, it is not believed that the Los Angeles Bureau of Power and Light is in a position to contract for the power by June 21. In this situation, the government's legal advisers in all probability will refuse to let the contracts go through, it is stated. Should an attempt be made, however, to exert undue pressure on the governmental agencies involved, assurance is given that injunction proceedings will be started in the federal courts to hold up the matter until the proper legal steps have been taken.

Flood-Control Plans Opposed

The Secretary of War, in the course of one of his conferences with newspaper correspondents, took occasion to state that the Jadwin plan is sound both from an engineering standpoint and from an economic standpoint. He admitted that the installation of controlled openings at the head of the Boeuf and Atchafalaya basins would commit the government to the payment of compensation for any damages resulting from the opening of the gates. It was stated at the Engineer Corps, however, that the chief reason why movable gates are not recommended is that the fuse-plug plan is more desirable from an engineering standpoint. Attention also was called to the fact that the residents of the floodway area would be inclined to prevent their opening, while the population on the other side of the river would be likely to demand this before it was absolutely necessary. Had there been gates at the head of the Boeuf Basin when the big sand boil developed recently at Greenville the opening of the gates would have been demanded and possibly undertaken by force, yet subsequent events have shown the levees were capable of carrying the stage of water then existing.

Local interests on the lower Mississippi are still objecting strenuously to the use of a needle dam at the head of the Bonnet Carré spillway. They contend that leakage will be excessive, that silting will result and that dangerous scour cannot be prevented. They contend that piers can be built at Bonnet Carré which will preclude settling and consequent binding of the gates. The gates, they point out, can be operated so as to hold velocities below the point that will cause scouring beyond the structure of the dam itself. The minute the stage has been reduced to a safe point the flow can be stopped and, with it, the deposit of silt. They also contend that a needle dam will cost $750,000 more than the gate type. The army engineers deny that the cost will be greater; that silt offers any problem or that dangerous velocities and scour will develop. They are unwilling to interpose the hazard of possible mechanical failure or binding of the gates. The gates, they state, will concentrate too much pressure on the piers, whereas the sill will carry two-thirds of the pressure on the needles.

Formal application for permission to raise and strengthen the levee at the head of the Boeuf Basin, in Arkansas and Louisiana, has been filed with the Secretary of War. This step is taken by the commissioners of the Tensas Basin Levee District, it is believed, in an effort to improve the legal position of the property owners in the proposed floodway. It is admitted that the levee board does not expect the War Department to grant the application, but an official statement to that effect, or a statement to the effect that the department has no authority to prevent the raising of the fuse-plug sector of the levee, seems to be a necessary step in the proposed litigation.

To Study Canal Routes

Secretary Good has under consideration the appointment of the engineering board which will report to Congress on interoceanic canals, particularly the Nicaraguan route. Before reaching any final decision as to the personnel of this board he expects to confer, the latter part of the month, with the Governor of the Panama Canal. Senator Edge, of New Jersey, has expressed the opinion that outstanding civilian engineers will be glad to serve on the engineer board without remuneration. He believes the present appropriation of $150,000 is enough to start the work and states that there will be no difficulty in obtaining further appropriations as they are needed.

The army engineers who are doing the preparatory work for the proposed board have compiled the data and material prepared by the Isthmian Canal Commission of 1899-1901, which recommended the Panama Canal's construction and also made a survey of the Nicaraguan project, making borings a mile apart along a proposed route.

Developing Alaskan Commerce

Development of Alaskan resources is being actively pushed by the new Interior Department administration in an effort to make the Alaskan railroad pay after many years of deficit. The department sees encouraging prospects of eliminating the annual loss which, though gradually decreasing, has cost the government about a million dollars. At present, rail shipments are largely inward, food, supplies and materials being sent in to the mining regions without being balanced by equal bulk of outgoing freight. The growth of the reindeer industry is seen as a promising means of remedying this condition. Buffalo herds also are being started, the buffalo being a cold-resistant animal, as is the reindeer. It is generally conceded that Alaska eventually will furnish important open range country. Mineral development is getting on a

stabilized basis now that the stampede for rich prospects is history and companies are working lower grade deposits by large-scale operations. Three large gold dredges were installed near Fairbanks last summer and two more are going in this year. The gold-bearing gravel deposits are said to be practically inexhaustible. Low-grade ores also are being mined. Large forest reserves are awaiting development for pulpwood and lumber, and the time of their utilization is being hastened by the air-mapping expeditions which have been studying available resources. The airplane has been a large factor in Alaskan progress. Points which otherwise could not well be reached are accessible by air taxi from Fairbanks and other bases.

Engineering Societies

CALENDAR

ANNUAL MEETINGS

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; annual meeting, Atlantic City, N. J., June 24-28.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, Toronto, Canada, June 24-28.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; annual convention, Milwaukee, Wis., July 10-12.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; annual meeting, Mexico City, Aug. 26-28.

THE CENTRAL STATES SEWAGE WORKS ASSOCIATION will meet at Indianapolis, Ind., June 20-21 for its third annual meeting. A number of papers are scheduled on various phases of sewage treatment and operation, including brief reports on the status of sewage treatment in eight Middle Western States.

THE DETROIT ENGINEERING SOCIETY on June 21 will hear a talk on "Construction of Detroit and Canada Tunnel" by Bernard R. Walue, executive engineer of Parsons, Klapp, Brinckerhoff & Douglas, New York City. An inspection trip is being arranged for the following day.

THE MONTCLAIR SOCIETY OF ENGINEERS, at its annual meeting June 10 elected Clemens Herschel, well-known hydraulic engineer, an honorary member. In submitting his name, M. N. Baker, of the editorial staff of *Engineering News-Record*, called attention to the fact that Mr. Herschel was not only the dean of the engineers residing in that section of New Jersey but that he was chief engineer of the East Jersey Water Company when the latter built the Pequannock water-supply system that now supplies Newark, from which Montclair and other communities are also supplied at present. The following officers were re-elected: president, H. S. Osborne; secretary, W. R. Smith; treasurer, Harry Barker. For new vice-president, Lyon J. Bevan was elected. Of two new committees to be appointed, one will keep track of water-supply matters in northeastern New Jersey and the other will deal with town planning.

Personal Notes

GEORGE A. RICKER, who has represented the Portland Cement Association in Washington for eleven years, has taken over the management of the association's educational bureau, which has its general office in Chicago. He will be succeeded at Washington by ARTHUR C. TONER, for many years district engineer of the association at Pittsburgh, Pa., and lately the regional manager in that section.

THOMAS H. ANDREWS has been appointed chief engineer of the Federal Bridge Company, of New York City. Mr. Andrews was formerly with the Mexican Federal Highway Commission and the state highway commissions of North Carolina and Florida.

E. B. DEBLER, engineer employed in the Denver office of the U. S. Reclamation Bureau, has been called to Washington to appear before the tri-state lower basin conference to give some facts and figures on the flow of the Colorado River.

GEORGE H. TODD has been appointed city manager of Phoenix, Ariz., succeeding W. C. Lefebre.

Major FRANK S. BESSON, U. S. Engineers, upon completion of a course at the Army War College in Washington, will take the post of district engineer at Nashville, Tenn., succeeding Major JOHN P. CONKLIN, who has been transferred to West Point as an instructor.

GEORGE B. FOLSOM, JR., civil engineer in the office of Jay T. Williams, building inspector for Denver, Colo., resigned May 18 to accept a position with the Kirchhof Construction Company, same city.

D. C. FENSTERMAKER has resigned as chief engineer of the North & South Railway, at Casper, Wyo., and has returned to his position as assistant engineer of the Chicago, Milwaukee, St. Paul & Pacific Railway.

R. W. RIGGSBY, who has been city manager of Durham, N. C., for the past eight years, has been selected city manager of Charlotte, N. C. Prior to his work at Durham, Mr. Riggsby was for two years city manager of Bristol, Va.-Tenn. Following his graduation from Massachusetts Institute of Technology, Mr. Riggsby was for four years engineer of Garfield County, Wash. After that he was on the staff of the Bureau of Municipal Research of New York City. He is president of the International City Managers Association.

Through a regrettable confusion of names a notice of the death of John Duncan MacVicar was published in these columns on May 30. The engineer whose death should have been reported was John MacVicar, district engineer of municipal roads, Toronto, Ont. John Duncan MacVicar, formerly an engineer for the Canadian Pacific and Grand Trunk Pacific railways, is now Right-of-Way Engineer, Department of Highways, State of Washington, with headquarters at Olympia.

Obituary

MILO S. MACDIARMID, Detroit, Mich., an associate engineer in the U. S. Lake Survey, died suddenly at Hancock, Mich., June 6, aged 57. Mr. MacDiarmid, who was a major of engineers in the Officers Reserve Corps, was in command of the U. S. S. "Margaret" for the past two years, engaged in deep sea sounding and magnetic work on Lake Superior. He was a graduate of Cornell University and had been connected with the United States Lake Survey for 27 years, including work on the Des Moines River Survey. For one year he was principal assistant engineer of the U. S. Lake Survey at Detroit. He was a member of the American Society of Civil Engineers.

CICERO D. HILL, for 37 years an engineer for the city of Chicago, Ill., died on June 2 at his home in that city. A graduate of the University of Michigan in 1880, Mr. Hill spent several years on surveys and construction on railway work and canal location. In 1888 he became assistant engineer on construction for the town of Hyde Park, Ill., and the following year was appointed assistant engineer on street pavement for Chicago. With the exception of five years spent in private practice on paving problems, he had been with the city since that date, holding successively the position of chief engineer of the Bureau of Sewers and chief engineer of the Board of Local Improvements. He was a member of the American Society of Civil Engineers.

WALSTAN E. KNOBLOCH, engineer with the Mississippi River Commission for many years, died June 3, at his home in Thibodaux, La. He was 77 years of age. After graduating from Tulane University in 1884, Mr. Knobloch became associated with the Louisiana State Board of Engineers and soon afterward with the U. S. Engineers. With the exception of about four years spent in railway surveying, he spent his entire professional life in river work, retiring about three years ago on account of ill health. He was a member of the American Society of Civil Engineers.

P. J. LANDERS, superintendent of the Indianapolis Union Railway and its engineer of maintenance-of-way from 1907 to 1916, died on May 25. Mr. Landers was born in Indianapolis in 1870. His early experience was on the Pennsylvania Railroad, where he became assistant engineer; about 1900 he went to the Minneapolis, St. Paul & Sault Ste. Marie Railway as division engineer and later to the Indianapolis Union Railway as assistant engineer, becoming engineer of maintenance-of-way in 1907 and superintendent in 1916.

Construction Equipment and Materials

Concrete Pavement Yardage

There is given below a tabulation of concrete pavement yardage awarded during the month of May, 1929, and also the total number of square yards awarded for roads, streets and alleys in the United States for the year 1929 to date as of May 31.

	Sq.Yd. Awarded During May, 1929	Sq.Yd. Awarded From Jan. 1, 1929, to May 31, 1929
Roads	17,517,585	40,436,468
Streets	5,735,194	15,532,614
Alleys	451,531	1,091,553
Totals	23,704,310	57,060,635

New Developments

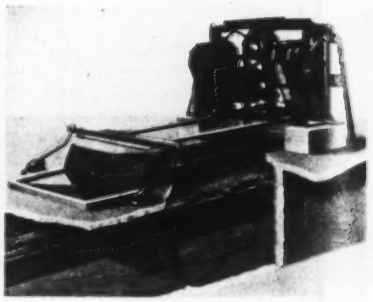
Power Pipe-Bending Machine Made in Two Sizes

Although used principally for bending pipe sections, the improved type pipe bender manufactured by the Wallace Supplies Manufacturing Company, Chicago, Ill., can also be used for bending tubes, conduits, reinforcement bars and light structural sections. The machine is furnished in two sizes, the smaller for pipe up to and including 2½-in. diameter and the larger for pipe as large as 3-in. diameter. The two models have maximum speeds of 2 and 1¼ r.p.m., respectively. Operation is by means of a single operating lever which starts the action forward or reverse. An automatic stop on the worm gear serves to stop the machine at any desired number of degrees of bend. Lubrication is by means of oil tubes leading to all-important bearings and

by grease packed into the worm and worm gear. Power is supplied by a 7½-hp. motor operating at 1,200 r.p.m.

Bar Screen Cleaned by Power

Cleaning screens used to remove debris from water flowing to turbines and similar units is greatly facilitated by use of a new bar screen with power cleaner now being made by the Dorr Company, New York City. The screen is of the conventional type using plain bars, usually ¼x3 in., placed in the channel at an angle of 60 deg. The opening between the bars can be varied to suit local conditions. The cleaning



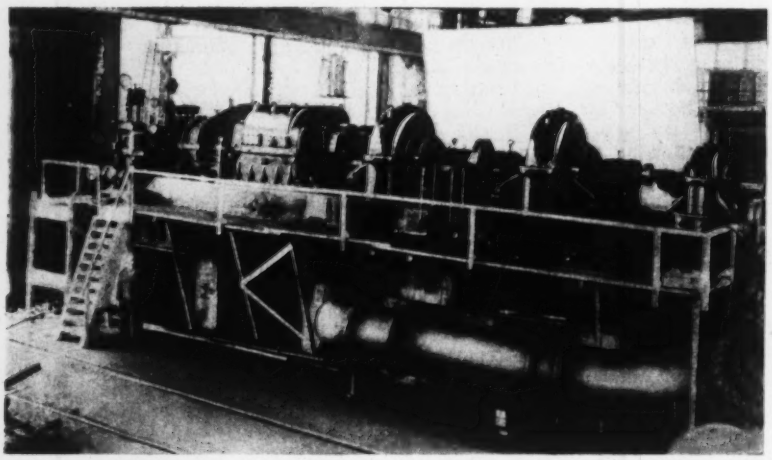
device has three parts, a raking mechanism, a pantograph drive mechanism and a rake scraper for removing the screenings. The driving parallelogram of the pantograph is actuated through a rack and pinion driven by a totally inclosed worm gear connected to a motor by a silent Texrope drive. On the rising stroke the raking plate travels close to the bars, removing any solids which have been deposited. As the plate clears the top of the bars it comes in contact with the rake scraper, which is carried on two hinged arms supported on the floor. Further movement carries the scraper upward and outward, discharging the solids onto a drainage platform or conveyor. A fixed apron is provided at the top of the screen to prevent screening from dropping back into the channel. Protection against overload is provided by an automatic cut-out switch for the motor, to which is connected a bell alarm.

Non-Clogging Centrifugal Pumps Offered in Three Types

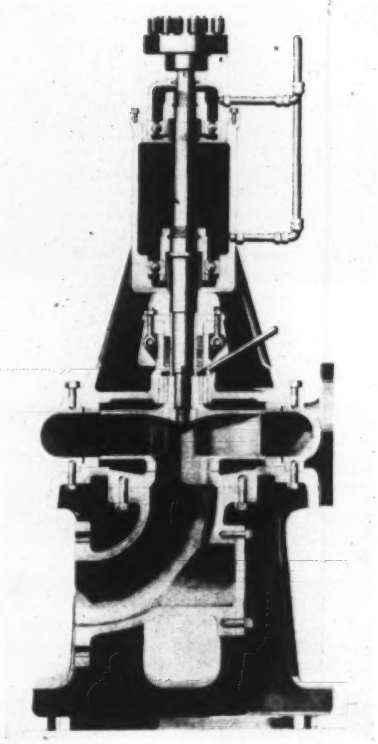
Centrifugal pumps of the non-clogging type for handling stringy or pulpy liquids without the use of strainers have developed rapidly in the past few years, until they now approach the efficiency shown by clear water pumps. As the result of considerable experimentation the Economy Pumping Machinery Company, Chicago, Ill., is now offering such pumps in a number of sizes and three different types containing numerous mechanical improvements. Pump capacities in the line range from the 3-in. 100-g.p.m. unit which will handle 2½-in. spheres up to a 10-in. 5,000-g.p.m. pump handling 7-in. spheres. Pumps of all capacities are made in three types: vertical submerged, vertical open shaft, and horizontal.

The vertical submerged type is principally used for handling sewage in buildings and industrial establishments where a self-contained unit is desired. The open shaft vertical type, shown in the illustration, is designed for installation in dry pump chambers such as are usually provided for in municipal sewage plants. Instead of operating in the liquid to be pumped, this is connected by a suction pipe to a wet well or chamber. In both these types the shaft pumps are frequently located a considerable distance below the driving motor, being connected by intermediate shafting supported at the upper level.

TURBINE-DRIVEN CENTRIFUGAL PUMPING UNIT FOR ST. LOUIS WATER-WORKS



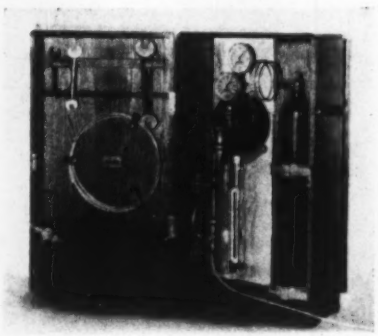
This illustration shows one of two high-head geared turbine - driven centrifugal pumping units recently manufactured by the De Laval Steam Turbine Company, Trenton, N. J., for the new Howard Bend station of the St. Louis, Mo., water-works. Each of the two units is designed for a maximum delivery of 60 m.g.d., against a 380-ft. head. St. Louis has also ordered three turbine-driven low-head units, two of which will have a 60-m.g.d. capacity and one 120-m.g.d., all against a 38-ft. head.



The horizontal pump is more generally used in industrial plants for pumping such materials as paper stock, foodstuffs or various types of sludge. Such pumps may be direct motor driven through a shaft connection or connected by belt or chain to any suitable power source.

Portable Chlorinator Developed

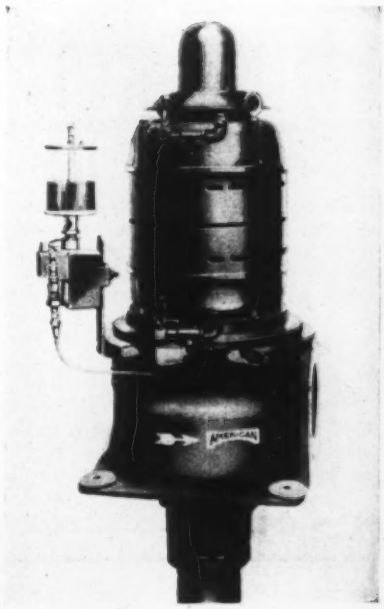
Originally developed for the water department of Syracuse, N. Y., a portable chlorinator has proved so satisfactory that it is now being distributed by the Paradon Manufacturing Company, Arlington, N. J., for use in sterilizing new water mains, dead end mains showing signs of after-contamination and for many other purposes which require temporary chlorination. The unit, all parts of which are interchangeable with the standard Paradon chlorinator, is also useful as a stand-by. It can be adapted to the use of sulphur dioxide, carbon dioxide and other chemicals.



The apparatus consists of a standard Paradon dry-feed chlorinator housed by means of brackets in a sturdy oak cabinet. This cabinet is provided with a door on both front and rear, and is so arranged that gages and control handles are accessible from either door. A 12-lb. cylinder of chlorine is fixed within the cabinet by adjustable clamps. Space is also available for the storage of wrenches and other auxiliary equipment. The chlorinator is of the direct-feed type, no auxiliary water supply or piping being necessary for its operation. Chlorine can be applied against pressures up to 25 lb. per sq.in. at ranges varying in the different models from 0.04 lb. to 300 lb. per 24 hours. A shut-off valve makes it possible for chlorine gas to be kept in the machine at all times under pressure, eliminating the possibility of water or moisture getting back into the apparatus and affecting its proper operation.

Deep-Well Turbines for Use in Small-Bore Wells

Turbines of the deep-well type in 6- and 8-in. sizes for use in small-bore wells are now being produced by the American Well Works, Aurora, Ill.



These follow the conventional pattern, consisting of the turbine head proper, which is the driving unit; the support pipe, which incloses the driving shaft, and the turbine itself. The turbine head consists of a vertical motor mounted on a compact and rigid base, with which is combined a thrust bearing designed to carry the load of the line shaft and impeller. The turbine proper is of the centrifugal type. All bearings are oil lubricated by gravity feed from the surface, and provision is made for complete drainage of all waste oil and water leakage through a discharge pipe located above the floor level so that the water will not be contaminated.

Business Notes

CHICAGO PUMP COMPANY, Chicago, Ill., announces additions to its sales staff as follows: Sidney Stiner at New York City, W. K. Hornbuckle at Memphis, Tenn., and Ray Trethaway at Detroit, Mich. The company's representative at Lincoln, Neb., formerly known as the Cornell Supply Company, has changed its name to the U. S. Supply Company.

LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, is loaning free of charge a two reel motion picture film "Arc Welding, the Modern Method of Pipe Line Construction."

OSWALD GRINER, Kansas City, Mo., manufacturer of engineering instruments and supplies, has moved his business into a new building occupying over 6,000 sq.ft. of floor space.

LUDLOW VALVE MANUFACTURING COMPANY, Troy, N. Y., has established a branch office at 11 West 42nd St., New York City. M. F. Smith Company, of New York City, will no longer distribute Ludlow products.

JOSEPH T. RYERSON & SON, INC., Chicago, Ill., announces the election of Edward L. Ryerson, Jr., as president, succeeding Joseph T. Ryerson, who will remain as a member of the board and treasurer.

BROWN INSTRUMENT COMPANY, Philadelphia, Pa., announces the appointment of Arthur W. Gray as associate director of research. He will be engaged chiefly in the development of scientific and industrial instruments.

CONSTRUCTION MACHINERY COMPANY, Waterloo, Iowa, manufacturer of Wonder and Marsh-Capron concrete mixers, CMC builders' hoists and pumps and Kern variable speed drag scraper power units, has appointed a number of new distributors in Texas. These are as follows: R. B. George Machinery Company, Dallas; McMillin Machinery Company, Houston; B. P. Clark Machinery Company, San Antonio; Plains Tractor & Implement Company, Amarillo; West Texas Tractor & Machinery Company, Plainview; and Golay-Kirkpatrick Tractor & Implement Company, Harlingen.

New Publications

Glass — MISSISSIPPI WIRE GLASS COMPANY, New York City, illustrates and describes all types of glass, both plain and wired, produced by the company in a new 650-p. illustrated catalog. Information is given concerning the illumination of modern industrial buildings, specifications for glass, and the importance of wire glass in fire protection.

Water Softeners—GRAVER CORPORATION, East Chicago, Ind., has issued a new 12-p. catalog describing the Graver hot process water softener. An unusual

feature is a colored flow sheet diagram printed on an extension of the front cover so that it can easily be referred to while reading the text. Several cost surveys are given, showing the savings resulting from use of the device in actual installation.

Centrifugal Pumps — ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wis., in bulletin 1642 describes the type "M" double suction, multi-stage centrifugal pump for use in high head installations.

Water Tanks—CHICAGO BRIDGE & IRON WORKS, Chicago, Ill., has issued a 24-p. booklet, "Fire Protection," describing the various methods and equipment used in providing private fire-protection systems. The book contains tables giving standard capacities and sizes of Horton tanks, and also a number of hydraulic tables.

Riveting Hammers—CHICAGO PNEUMATIC TOOL COMPANY, 6 East 44th St., New York, has issued a bulletin giving full specifications of the Boyer riveting hammer.

Diamond Drills—SULLIVAN MACHINERY COMPANY, 122 South Michigan Ave., Chicago, Ill., has issued a new catalog 85-B listing and describing complete equipment for use with diamond core drills. The book contains 56 pages and is fully illustrated.

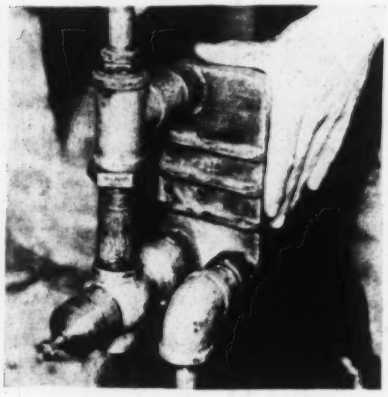
Construction, Labor and Material

Arbitration Committee in New York Building War to Act June 20

The arbitration committee, which will attempt final settlement of the dispute between contractors and building trades unions in New York City, is to convene Thursday, June 20.

A threatened tie-up of construction, alluded to in *Engineering News-Record*, issue of June 6, p. 928, has been temporarily avoided through the influence of Supreme Court Justice Crain, who acted as conciliator in effecting an armistice.

As a result of this agreement, seven pacific moves have been made: (1) electricians have returned to work; (2) other crafts which acted in sympathy with the electricians have returned to work; (3) electricians have agreed to furnish union men to members of the Building Trades Employers' Association; (4) employers have agreed to use these men to replace electricians who are not members of the Electrical Workers Union, Local No. 3; (5) electricians have withdrawn their objection to handling fixtures made in non-union shops, pending arbitration of this question; (6) employers have rescinded a threatened lockout of 75,000 building trades mechanics; (7) the cement workers' union has withdrawn an injunction obtained against the lockout.



AUTOMATIC DEVICE SHUTS OFF PIPES IN FREEZING WEATHER

Protection of piping systems from damage by freezing is provided by a newly developed automatic shut-off and drain which does not depend upon a thermostat or any other mechanical device for action. All water entering the system is passed through a brass freezing chamber which spreads the water into a thin sheet. This flattened stream freezes at a temperature 10 deg. higher than that which would freeze water in the pipes. Within the chamber, the ice takes the form of a wedge at inlet and outlet points, choking the chamber and stopping all flow. At the same time expansion of the ice exerts pressure against a metal diaphragm which opens a drain valve and empties the piping system. When the weather moderates the thin sheet thaws quickly and water is readmitted.

At the outset, electricians demanded the five-day week with a 10 per cent wage increase, Jan. 1, 1929. The Electrical Contractors' Association resigned from the Building Trades Employers' Association in order to make a separate agreement with the mechanics. Three electrical contractors, however, refused to grant the increase and, accordingly, returned to the employers' association. This precipitated a strike among electricians who were working at the time on jobs of the dissenting contractors.

Bricklayers were the next to gain the five-day week with a 10 per cent wage increase. Their agreement went into effect May 1, 1929.

The plumbers received the five-day week with 10 per cent wage advance, May 20, 1929, to become effective Aug. 1, 1929.

The Building Trades Employers' Association, finding itself unable to reach an agreement with the Electrical Workers' Union, rescinded the five-day week order, together with the wage increase for all crafts, and declared a lockout which, in turn, was thwarted by a restraining court order obtained by the United Cement and Concrete Workers' Union.

In addition to all this there remains one other feature which contains possibilities of serious obstruction to the summer building program at New York. At least 2,000 truck drivers formerly employed by the masons' materials dealers are still on strike. This trouble started May 1 and has had no serious consequences thus far, owing to the fact that the dealers are able to make deliveries on at least 60 per cent of their orders through the use of yard men and other employees in manning the trucks. If, on the other hand, drivers handling terra cotta and concrete aggregate materials should take a proposed strike action similar to that of the other drivers, a complete tie-up of construction operations might easily result.

High Money Rates Reduce New Capital Issues

For the first time this year monthly flotations of new capital fell below $1,000,000,000. High money rates, which had no effect on totals in the first three months, are reflected sharply in the April figure, which is $677,000,000, compared with $984,000,000 net for March and $690,000,000 for April, 1928.

The heaviest decline from the preceding months is in public utility financing, and in metal and coal company financing. The real estate figure is also down, more than half. The character of this decline is the same with respect to April, 1928. Municipal financing amounts to $85,000,000, compared with $98,000,000 in March and $123,000,000 in April, 1928.

This decline is in keeping with the money situation. Corporations hesitate to float bond issues carrying high interest rates, particularly at a time when the public is thinking less of bonds than of other securities.

An indication of the state of the money market is the sale by New York City of $52,000,000 corporate stock of 5¼ per cent, the highest rate in years. In February, 1928, the same amount of corporate stock was disposed of at 4 per cent, which cost the city 3.866 as compared with the recent cost of 4.8065.

E. N.-R. Index Numbers

	Cost		Volume	
June 1, 1929	**205.65**	**May, 1929**	**395**
May 1, 1929	205.15	April, 1929	332
June 1, 1928	206.15	May, 1928	299
Average, 1928	206.78	Average, 1928	287
Average, 1927	206.24	Average, 1927	263
1913	100.00	1913	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of June 13, with some comparisons, total as follows:

(In Thousands of Dollars)

	June 13, 1929	June 6, 1929	June 14, 1928
Building:			
Industrial	$8,604	$13,775	$6,647
Commercial	41,274	50,008	41,729
Streets and roads	13,608	30,168	21,134
Other eng. constr.	13,578	10,994	8,971
Total	$77,064	$104,945	$78,481
Total, all classes, Jan. 1 to June 13:			
1929			$2,091,769
1928			1,596,957